

Progress Report for Middle Rio Grande Fuels Reduction Study 2000-2002

Rocky Mountain Research Station-Albuquerque, New Mexico



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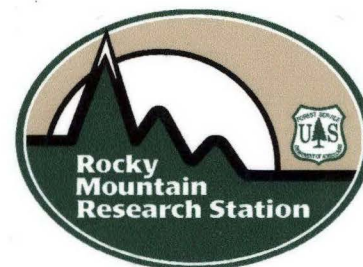


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Introduction

Project Overview

Since the turn of the century, riparian habitats along the middle Rio Grande have become more xeric due to river regulation, including flood suppression, irrigation and channeling, reservoir construction, and urban development. Drying of the river has facilitated the spread of introduced exotic woody plants such as Russian olive (*Elaeagnus angustifolia*) and salt cedar (*Tamarix ramosissima*). River regulation, particularly flood suppression, also increases the frequency of fire along rivers such as the Rio Grande due to the propensity for flammable biomass to accumulate. Along the Middle Rio Grande, the increasing proliferation of exotic woody plants has altered the structure and composition of riparian vegetative communities, and greatly increased the frequency and severity of wildfire. Dead and downed wood and exotic salt cedar and Russian olive are fuels that lead to high fire risk in the bosque. Salt cedar plants, in particular, possess many stems and have high rates of stem mortality, resulting in accumulations of dense, dry dead branches. When dense salt cedar stands burn, the fires are often intense and fast moving. Salt Cedar's high flammability places native Bosque flora and fauna at increased risk of mortality by fire. Native tree species inhabiting the middle Rio Grande, such as the Rio Grande cottonwood (*Populus deltoids* ssp. *wislizeni*) and Gooding's Willow (*Salix gooddingii*) are not fire-adapted and thus cannot resist fire damage or respond with regenerative resilience to fires (Busch, 1995). Fuel reduction treatments are needed in the Middle Rio Grande Bosque (woodland) to prevent the further spread of wildfire, control increasing firefighting costs/labor in the Bosque, reduce fire risks for local residents, and preserve native riparian plant and animal communities. Removal of

these invasive woody species, and subsequent herbicidal and fire treatment in removal areas, has unknown consequences for wildlife species, including sensitive, threatened, and endangered vertebrate species known to inhabit woodlands along the Rio Grande. Comparison of 'pre' and 'post' treatment data will provide vital information concerning the short and long term ecological costs and benefits of fuels reduction programs in southwestern riparian systems.

The Rocky Mountain Research Station's (RMRS) Middle Rio Grande Fuels Reduction Study is currently in the process of monitoring and evaluating the response of vegetation, bird, bat, reptile, and amphibian populations, and hydrological features to three fuels reduction treatments at specified research sites. The fuel reduction study was initiated in 1999 under a Memorandum of Agreement among several partners, including Bosque del Apache National Wildlife Refuge, Middle Rio Grande Conservancy District, City of Albuquerque Open Space, Bureau of Land Management, New Mexico Department of Environment, and NRCS Plant Materials Center, Los Lunas, NM. Pre-treatment data were collected for three years (2000-2002). Treatments were initiated in fall 2002 and will continue through 2003.

A related study on Fire Effects in the Middle Rio Grande was established by RMRS in 2001, and a joint venture between RMRS and University of Oklahoma to broaden the fire effects study to include artificial nest studies was initiated in 2002. (The progress report for the fire effects study includes the study plan enclosed in the Appendix as well as some results described in the text that follows)(Appendix 7,8).

The fuel reduction study is directed toward identifying the most effective fuels-reduction and exotic plant removal practices that will simultaneously 1) preserve

cottonwoods and other native trees and shrubs, 2) reduce catastrophic fire risk via control of exotic plants and fuels, and 3) have positive or least-negative impacts on native wildlife species. Treatment types were designed with the goal of creating sites where the risk of catastrophic fire would be greatly reduced by lowering fuel levels. Ideally, this goal would be implemented by reducing fuels at the selected sites to a range of 5-30 tons per acre, with an operational goal of 15 tons/acre. The following exotic / fuel removal treatments are being implemented in this study: 1) mechanical removal of dead and downed wood and exotic shrubs / trees, 2) partial mechanical removal of dead, down, and exotics followed by light, prescribed fire, 3) mechanical removal of dead, downed, and exotics followed by revegetation with native plants, and 4) control, no treatment. A research-study team agreed upon treatment types and goals prior to site selection. Treatment prescriptions were created to follow the recommendations of the Draft Prescription Guide for the Rio Grande Bosque (Appendix 1). More information about prescriptions can be obtained in the Environmental Assessments on file with Bosque del Apache National Wildlife Refuge and Middle Rio Grande Conservancy District. The prescription being utilized is for larger, C1- categorized sites.

Project Status

Bird crews have collected three years of pre-treatment data using point counts, nest surveys, evaluations of nesting success, habitat measurements, and fuel load measurements at 12 fuel reduction sites along the Middle Rio Grande basin. Bat activity has been monitored at each of the twelve sites for the past two seasons (2001-2002) and three years of herpetofauna monitoring data have been collected at the same sites (2000-2002). Hydrological activity has been monitored and recorded over the last two years,

including on-going monthly monitoring. Each of these portions of the study will be discussed in greater detail in the following pages.

Treatments are currently being implemented at fuels reduction sites located in two of the research blocks. Beginning in the fall of 2002, all treatments are scheduled to continue through 2004. However, the 2003 field season, beginning in May and continuing to September, will include biological surveying on all study sites following the methodology outlined in this progress report.

Methodology

Study Sites

The Rocky Mountain Research Station worked with the several land managers; the MRGCD (Middle Rio Grande Conservancy District), COA (City of Albuquerque), USFWS (US Fish and Wildlife Service), and the NMSP (New Mexico State Parks), to determine which sites along the river would be suitable research areas. After selection, research sites were divided into three blocks in accordance with a randomized block design. Randomized block designs are appropriate when a population of experimental units has recognizable structure, in this case riparian cottonwood galleries, and one can utilize that structure in assigning treatments (Williams et al., 2001). The three blocks; North, Middle, and South extend, respectively, approximately 129 km from the southern portion of the city of Albuquerque to the Bosque del Apache National Wildlife Refuge (Figures 1, 2, 3, 4, 5). The following criteria were used for research site selection: 1) sites had visibly-high fuel loads as identified by landowners and NM Environment Department, 2) the site had relatively homogenous vegetation, at least 20 hectares in size, 3) sites had a cottonwood overstory and an understory with exotic woody plants, 4) sites

were accessible by road, 5) access and block design treatments were permitted by landowner, and 6) sites were relatively undisturbed by grazing, vehicles, and other uses. Study areas have an average size of 20.41 hectares per site (Table 1).

Each management agency is responsible for carrying out treatments on the land that they manage in accordance with the MOU.

Research Focus

Soils and Hydrology

Soils, hydrology, and weather are basic environmental parameters that dictate the types of ecosystems in the Rio Grande Bosque. The treatments proposed in this study could have the potential to alter hydrological and soil conditions with consequent effects on habitats of plant and animal species that live there. A subset of these factors is being measured and monitored: depth to water below the soil surface, salinity of surface soils, and precipitation.

Water is critical to the establishment, growth and development of all plant species. The primary sources of water for plants growing in the Bosque are precipitation, ground water, and surface water. Rapid changes in the depth to water (in the soil) can kill existing plants and/or create unfavorable conditions for new plants. Therefore, it is necessary to determine the effects that the treatments could have on the depth to water at the research sites. Two 2-inch (5.08 cm) diameter observation wells were installed on each fuels reduction site to monitor fluctuations in depth to water below the sites.

Soil compaction is directly linked to the water cycle and plant regeneration in the Bosque. If soils become too compacted from heavy equipment and traffic, precipitation is unable to infiltrate the soil as readily as before. Instead, the water ponds on the

surface, where low areas exist and creates run-off into the river. Compaction can also reduce the recharge rates to the groundwater, which can reduce the water available for native plants in the area. In areas where revegetation is planned, compaction can affect growth of species of plants, due to the increased bulk density of the soils. Soil bulk density measurements will be taken before and after restoration treatments at each of the research sites in order to assess what damage, if any, is done to soil structure.

Bat Surveys

Bat activity was monitored at each of 12 sites with Anabat detection systems during the summers of 2001-2002. The number of echolocation call files recorded per night is used as an index of bat activity (or BAI). Although every attempt was made to sample bat activity at each site once per week throughout the summer, not all nights were successful due to adverse weather conditions or equipment problems. Each site was monitored for 8-11 nights each summer, and each site contained 3 monitoring stations. (Figure 6). Effects of fuels reduction treatments will be determined by comparing pre- and post-treatment activity indices. By reducing dense understory vegetation, treatments will likely reduce obstructions, which impedes flight of many bat species. Thus foraging and commuting activities may increase below the canopy. However, bat activity will also reflect the availability of insects. Depending on the impact of treatments on prey species, foraging activity may be positively or negatively affected. Due to time constraints, insect species composition and abundance are not being examined concurrently.

Herpetofauna Surveys

Herpetofauna are being monitored at each site through the use of drift fence arrays and pitfall and funnel traps (Figure 6). Only lizards were marked to identify recaptures. To

determine the effects of fuels reduction treatments on herpetofauna, richness and abundance of amphibians and reptiles will be compared among treatments and years. To identify potential causes of observed differences, changes in richness and abundance will be compared to changes in vegetative characteristics. Initial declines in richness and abundance are expected immediately after treatments are implemented due to the loss of coarse woody debris, leaf litter, understory vegetation, and other important microhabitats (Enge and Marion, 1986).

Breeding Bird Surveys

Point Counts

At each study site, approximately eight point count stations were established along a north to south gradient based on global positioning system (GPS) coordinates (Figure 7). Channelization of the river determined that transects would be linear. All stations were positioned 150 meters apart and the majority were 75 meters from boundary edges. There was one point count station per 2.5 hectares.

Generally, the point count methods utilized in this research follow the recommendations of Bibby et al (1992). All points were sampled an average of five times per season, with each transect surveyed in a north-south direction alternately. A round of surveys for all sites was completed before beginning a new round. Point counts were performed every other week during the breeding season. During each count, the observer at each point recorded all birds seen or heard for 8 minutes. Detection mode (heard, seen), sex, relative age of bird (AHY, HY), and distance from point (m) was also recorded. Species identification and distance estimations were checked across observers by informal testing throughout the sampling season. Each observer was trained to

estimate and record distances to each bird. Each transect was surveyed by 3-5 different individuals over the course of each of the three pretreatment seasons to standardize observer bias (Verner, 1985).

All counts were conducted within the first four hours after sunrise with the first count beginning within half an hour of sunrise. Counts were conducted only on days without precipitation or strong wind. Before beginning each count, the observer waited for 1-2 minutes to allow birds to resume their normal behaviors.

Standardized detection rates were computed for all species detected at the fuels reduction sites. Rates of detection, for each common species, were calculated by taking the total number of detections (per site) and dividing that number by the total number of survey minutes. This number represented the number of detections (seen/heard) of that particular species per survey minute. The number of detections per survey minute was then multiplied by one hundred to provide an index of abundance.

Nest Searching / Monitoring

Each research site was searched for active nests on a regular and consistent basis during the main breeding season (15 May to 15 July, approximately). Nest data sheets were filled out for each active nest. Data sheets included a nest identification number, species identification, GPS location; directions to the nest (geographical and microscale), and a nest check record. Nest check records included monitoring dates, nest stage, nest contents, and detailed observation notes. Nests were monitored until a nest fate was determined. Additional behavioral observations were also recorded whenever possible. After the nesting season ended, additional data measurements such as nest height, location of nest in plant, nest material, nest tree size and tree condition were collected for

each nest. Extensive additional nest characteristics were collected at nests of the most common breeding species.

Vegetative Surveys and Fuel Load Inventories

The vegetation surveys were analyzed at three levels: landscape-block, site-patch and local-plot. Each level will be discussed along with corresponding vegetative components.

General Vegetation Survey

These values were quantified using locally accepted classifications. The ecological classifications followed the scheme described in "Handbook of Wetland Vegetation Communities of New Mexico" (Muldavin, et. al,) (Appendix 2). The vegetation structure was classified according to Hink and Ohmart (Appendix 3). An area fifty meters in diameter was centered at each bird point count station in order to collect information relating to ecological characteristics, vegetative structure, and fire history.

Variable Plot Measurements

At each site, plot centers were established approximately 25 meters from bird point count stations using the diagonal azimuth (i.e. NW). Herpetological array plot centers were established 25 meters from the center of the herp pitfall trap fences. Azimuths were chosen in a predetermined order. Two plots were established at each bird point count station and one at each herpetological array.

A 20 Basal Area Factor was utilized for the variable plot sampling. Individual trees were counted by using the appropriate prism. A tree was counted if the displacement of the prism still touched the tree at approximately breast height. The selected tree was then identified to species, categorized as living or dead, and measured

for DBH. In cases where a tree had more than one stem displaced by the prism, only the largest stem was counted.

These measurements were entered into equations acquired from the Region 3 Stand Exam Program. This allowed for calculation of basal area, trees per acre and average diameter for each tree species.

A densiometer was used to measure percentage of crown closure. A densiometer reading was taken facing north and south by counting the number of closed points in each direction. The two readings were then averaged and converted to a percentage to characterize canopy cover at the point. The average for each point was then used to determine canopy cover for the entire plot.

Fixed Area Measurements

Four-meter radius circular plots were established to characterize understory and ground cover on each plot. This produced an area of 50.272 square meters or approximately 1/200 of a hectare for each plot. All plants within the circular plots were identified and counted.

On all plots, woody plants with a DBH > 5 cm were measured for DBH, characterized as alive or dead, and identified to species. For one plot at each bird point count station, all exotic woody plants were identified, counted and measured for DBH. In compliance with the variable plots, only the largest stem was counted when a plant had more than one stem.

All understory plants were identified and counted. All native trees and shrubs were counted. Forbs and grasses were counted or estimated at 1, 25, 50 or 100+.

A fixed 1-meter radius plot was established at each point using the same center as the variable and 4-meter plots. All live exotic stems > 2 cm in diameter (at the base) and all other woody stems were counted in within this plot. This data was expanded to a per acre or hectare basis to calculate stem counts for the entire plot.

Overstory Vegetation Layer

The overstory layer was defined as trees greater than 10.1 meters in height. Canopy closure is a good ecological descriptor for middle Rio Grande riparian forests. Canopy closure was measured at the same locations utilized for habitat structure data collection.

Standard deviation and minimum and maximum canopy closure categorizations were used to measure site homogeneity.

Understory Vegetation Layer

The understory layer was defined as all woody shrubs and trees .5-10.0 meters tall and was measured using the methodology for fixed radius plots.

Ground Cover

Classes (Bare, Forb, Grass, Litter, Dead/down, Shrub, Tree, Other) were used to categorize types of ground cover along the 50 meter transects. Classes were designated at each meter along the 50 meter transect, tallied, and then converted into percentages.

Litter depth was measured to the tenth/cm at every fifth point where litter existed.

Differences were then analyzed between sites.

The vegetative ground layer consisted of plants up to .5 meters tall and was not sampled as rigorously as other vegetative layers. The ground layer was sampled for relative abundance only.

Existing Snags

All dead trees located in the variable vegetative plots were measured. Average tree size, snags/HA and Basal area/HA were then calculated.

Dead and Downed Survey

One 50 meter intercept transect was established for each bird point count station and herp array, originating at the center of the vegetation plots. Dead and downed pieces (course woody debris) were measured along the transect line. The pieces were separated into three size classes: 2-5 cm, 5-20 cm, >20 cm and four height classes: 0 - 0.5 m, 0.5-1.0 m, 1.0 - 1.5 m, 1.5 – 2.0 m. Dead pieces higher than 2 meters above the ground were not counted. Results were averaged for each site and then compared across sites.

Fuels Inventory

The fuels targeted for treatment are grouped into dead and down, and live exotic trees. Fifty-foot transects were established at the center of each vegetation plot. Two transects were established at each bird point count station. Fuel data collection was based on sampling procedures for planar intercepts. Fuel pieces were counted by size class as they intercepted the transect line, following the procedure established in the attached document (Appendix 4). Fuel pieces greater than three inches (diameter) were identified to species and measured to the nearest half-inch. The duff depth was measured twice on each transect. Fuel depth was measured three times along each transect.

Resulting data were entered into the “Fuel Management Suite” (Fire Program Solutions, L. L.C. 1998). The Planar Intercept program was used to produce fuel load per type (tons/acre) and average duff and fuel bed depth (in.).

Exotic stems were counted at one fixed area plot per bird point station. Each exotic plant was identified to species and measured for DBH. Height and crown ratios for each species were calculated. The Crown Mass Inventory portion of the Fuel Management Analyst Suite was used to determine fuel loading by type (tons/acre).

Results

Soils and Hydrology

Depth to water is a key factor, which determines the type and extent of vegetation found in these riparian ecosystems. The depths to water for each site during 2002 are summarized in Table 2. The data collected related to vegetation and fuel loading are summarized in Table 3. The relationships between the depth to water, vegetation and woody fuels were tested using Pearson's correlation analysis and scatter plots (SAS 2002). The analysis showed that most of the relationships between depth to water and vegetative parameters are negatively correlated (Figures 9 and 10). The basal area of the exotic woody species had the strongest correlation with depth to water (-0.66275 ; $p = 0.0188$). The scatter plot for this relationship shows that there is less basal area coverage of exotic woody species on sites with deeper water tables.

Conversely, the analysis generated a positive, but weak correlation (0.25489 ; $p = 0.4240$) between native woody species and the depth to water. Reasons for these differences could be attributed to the different growth characteristics and requirements of the native and exotic species. The largest component of the native woody species consists of Rio Grande cottonwoods. Most of the existing cottonwoods are older and larger than the exotics. They were also established under hydrologic conditions much different than those that exist today. Historically, the river overflowed its banks creating disturbed

moist sites with nutrient rich sediments brought down from the upper watersheds, which cottonwood seeds require to germinate. New areas for growth of cottonwoods were also created when high flows meandered across the floodplain, scouring new channels and often dislodging smaller and less established vegetation in its path. Today the river is confined to a narrow entrenched channel by numerous dams, diversions and levees, which have caused the water table to drop below historic depths in bordering areas. While established cottonwoods have been able to adapt and mature under the changing hydrologic regime they are not regenerating except in small quantities. In their absence exotic woody species such as salt cedar and Russian olive are flourishing. These exotic species are less restrictive in their needs for water and are therefore occupying sites that are no longer suited for native woody species.

The main fuel components of catastrophic fires in the Middle Rio Grande bosque are excess amounts of dead and down woody materials and live exotic species. Correlations computed for the relationship between dead and down woody materials and the depth to water are significantly negative (-0.63702 ; $p = 0.0259$). The scatter plot for this relationship suggests that greater amounts of dead and down materials are associated with sites that have shallower water tables (Figure 3). A weaker correlation exists between live exotics and depth-to-water (-0.35471 ; $p = 0.2579$). Together, these analyses demonstrate that there are greater fuel loads on sites with lower depths to water. This relationship may develop over time as mature overstory cottonwoods die, leaving dead and down material, and are replaced by adaptable exotic species with greater stem and foliage densities.

The USDA Natural Resources Conservation Service (NRCS) Plant Materials Center (PMC) in Los Lunas, NM will revegetate three of the 12 sites treated in this study (Table 2) with native tree and shrub species. Because the Rio Grande Valley receives less than 20 cm of annual moisture, the vegetation will be installed as dormant 4.5 m pole cuttings or as containerized transplants with 74 cm rootstock. This vegetation will be planted in holes that have been augured to the capillary fringe of the water table. The plants should not require any irrigation, which is normally required for transplants to obtain satisfactory survival. The PMC will use a mixture native trees and shrubs common to the area which they produce in a nursery. Besides being adapted to the Bosque, many native shrubs offer the benefit of producing fleshy fruits that are readily consumed by many wildlife species. After planting, the trees and shrubs will be monitored for survival and growth.

The results and analysis presented here offer a preliminary look at the information being collected for the fuels reduction study. As other data collection efforts are completed and we analyze the information, our understanding of the relationships between ecosystem parameters in the bosque and how the fuels reduction treatments are affecting them will be enhanced. Other data being collected includes soil classifications and soil compaction before and after treatments. A few of the relationships that we will be able to access include spatial effects of treatments (north to south), changes over time (5+ years), changes with varying water supply (precipitation, runoff, ground water, etc.).

Bat activity

The Bat Activity Index (BAI) was averaged over the summer for each station, and BAI for the site was the average of the 3 stations. BAI ranged from 2.86 to 220.19 per

site (Table 4). There were no significant differences in BAI between years at each site (Table 4). Activity appeared to be highest in South sites and lowest in Middle sites.

Herpetofauna

During the summers of 2000-2002, 8412 animals were captured, including 642 amphibians, 1135 small mammals, 6584 lizards, and 51 snakes. Captures included 21 species of lizards and snakes (Table 5), 8 species of amphibians (Table 5), and 9 species of mammals (Table 6). From 2000-2002, 58.6% of lizards captured were new animals (n=3857) and 40.1% were confirmed recaptures (n=2640). Neonates constituted 34.2% of new lizard captures (n=1319). Five species (*S. undulatus*, *C. exsanguis*, *C. neomexicanus*, *B. woodhousii*, and *E. obsoletus*) were abundant and common throughout the study area (i.e. present on ≥ 10 sites) and accounted for 81% of all captures (Table 2). *C. uniparens* was locally abundant on the southernmost study sites (i.e. South block) and accounted for an additional 12% of all captures. Sufficient numbers of 6 species have been captured to allow individual species analysis.

Point Counts

Breeding Bird Surveys

Three years of timed standard protocol surveys were completed for all three blocks of the fuels reduction study. Over the course of three seasons of pretreatment data collection, a total of 115 avian species were seen or heard at the fuels reduction study sites (Table 7, 8). Eighty-one different species were documented after completing two years of surveys on the fire effects study sites. Although there was variation in the skill levels of observers, there was a significant difference between the suite of birds utilizing unburned cottonwood galleries and those using recently burned areas. For example,

Western kingbirds (*Tyrannus verticalis*) were much more evident in recently burned patches, while summer tanagers (*Piranga rubra*) were observed more frequently in unburned cottonwood galleries (Table 12).

Roughly seventy-five percent of the most common Bosque birds were seen and/or heard during survey periods in the South block of research sites (Table 7). There does appear to be some variation in distribution of species along a North–South gradient. Phainopeplas (*Phainopepla nitens*) and Lucy’s warblers (*Vermivora luciae*), in particular, were frequently seen in the South block of sites, but never at sites in the north. South 2, the research site with the highest amount of native understory vegetation, also had the highest number of riparian bird species detected (Table 7). American Kestrels (*Falco sparverius*), Phainopeplas (*Phainopepla nitens*), and Yellow-breasted Chats (*Icteria virens*) showed much higher rates of detection at South 2 than at all other fuels reduction sites. Observations of Chats in the South block were double the rate of the Middle or North blocks, while observations of Kestrels were almost triple (Table 7). American Kestrel prevalence at South 2 is most likely correlated to prey abundance (high detection rates of reptiles (Table 5) and small birds (Table 7)) and preference for existing geographical features (i.e. large, open areas surrounding plot and suitable nesting habitat). Conversely, the most common species, Black-chinned Hummingbird (*Archilochus alexandri*) showed much greater use of northern sites, where Russian Olives were predominant and where sites exhibited a higher percentage of canopy cover (Figure 11, 13)(Table 17).

Winter Bird Surveys

Each site was surveyed once in January or February of 2002 and 2003 in order to obtain a sample of wintering bird populations. Survey methods used were the same as those used for breeding season surveys. A total of 68 species were recorded on the sites during the surveys, 46 in 2002 and 60 species in 2003. The most commonly recorded species utilizing the Bosque habitat are shown in Table 9. American crows (*Corvus brachyrhynchos*) were the most frequently detected species both years, mainly due to a large roost near the North block of sites. Considerably more species and greater numbers of birds were recorded in 2003 than in 2002. Many of these birds were montane species, such as Steller's Jays (*Cyanocitta stelleri*) and Western Scrub-Jays (*Aphelocoma californica*), or frugivores such as American Robins (*Turdus migratorius*) and Cedar Waxwings (*Bombycilia cedrorum*). The presence of these birds in the Rio Grande valley is likely related to the continuing drought conditions in the region.

Nest Monitoring

A total of 580 nests, representing 33 species, have been located on the 12 fuels reduction sites since the study began in the summer of 2000. Nest fates, categorized as "successful" or "failure", were determined for the most common riparian species (509 nests) (Table 10). The remainder, categorized as "unknown", will not be used for statistical analyses. The most commonly found nests (253) were those of the Black-chinned Hummingbird. Black-chinned Hummingbirds had an overall nesting success rate of approximately 67.35% and appeared to use exotic trees (Russian Olive, in particular) more often than native plants as nest sites (Table 11). Initial assessment of data collected during the first two years of the study indicated that Black-chinned

Hummingbird nesting success was not significantly related to use of exotic versus native plant substrates (Table 27). However, after analysis of three years of pretreatment data, greater differences in hummingbird nesting success among substrates are observable (Table 10). Further analyses will continue over the next several months. Blue Grosbeaks (*Passerina caerulea*) also show a preference for understory exotics but appear to have a fairly high rate of nest failure (70 %). The highest rates of detection for both Blue Grosbeaks and Brown-headed Cowbirds (*Molothrus ater*) were seen at South 1 (Table 7). It would appear that the high rate of nest failure for Blue Grosbeaks might be the product of parasitism by Brown-headed Cowbirds. How birds such as these respond to the removal of their preferred nesting plants will be one of the questions that we will address by collecting and analyzing post-treatment data.

Raptors, such as Cooper's Hawks (*Accipiter cooperii*) and American Kestrels (*Falco sparverius*), and cavity nesters displayed very high nesting success rates when compared to the rates seen with cup-nesting species (Table 10). With the removal of a large percentage of cavity nesting sites (i.e. snags) at fuels reduction sites, it can be anticipated that the number of cavity nesting species monitored at these sites during the pretreatment phase of the project will decrease in number.

Nest searching and monitoring was conducted on four fire effects sites in 2001 and 2002 (Table 12). A total of 74 nests were located on these plots. Mourning Doves (*Zenaida macroura*) appeared to utilize recently burned habitats more frequently than other riparian species. Twenty-one Mourning Dove nests were monitored during the course of both breeding seasons. Overall nesting success, for all species observed, was slightly lower on the fire effects sites than on the fuels reduction sites.

Use of Course Woody Debris by Avian Community

Course woody debris (CWD) has been positively associated with avian diversity and abundance (Lanham and Guynn, 1993). Snags (standing woody debris) are a critical resource for certain bird species. They are used for breeding and roosting, as well as providing substrates for perching, foraging, and communication. Cavity nesting species may experience a decrease in nesting opportunities because of a lack of suitable nest sites. Hence, with the removal of cavity nesting sites (i.e. snags) at fuels reduction sites, it can be expected that the number of cavity nesting species monitored during the pretreatment phase of the project will decrease.

Along the Middle Rio Grande, it would be expected that species such as the Bewick's Wren (*Thryomanes bewickii*), Ash-throated Flycatcher (*Myiarchus cinerascens*), Downy Woodpecker (*Picoides pubescens*), and American Kestrel (*Falco sparverius*) would be affected. According to 2000-2001 breeding surveys, there is a positive relationship between Bewick's Wrens and the existence of logs 20 centimeters or greater (dbh) (Figure 15). Hence, Bewick's Wren populations will be affected by removal of logs 20 cm or greater (dbh) at fuels reduction sites along the Rio Grande. Prey species' populations (reptiles and arthropods, in particular) would also be affected by removal of snags and dead and downed woody debris. In older plant communities (i.e. North Block), where there is a high probability for snags and dead/downed wood to exist due to the maturation of large trees, a significant difference in the composition of the avian community would be expected to be seen.

Vegetative Data and Fuels Inventory

Vegetative Overview

The North block is dominated by Cottonwood / Russian Olive types, while more Cottonwood / Salt Cedar types exist in the South block. Mesic sites, which have higher average surface water depths, are more common in the Middle block (Table 2, 13). The north block exhibits more structure I habitat than the other blocks, due to the domination of older, larger trees in the overstory (Table 14). The South block contains more III, IV, and V vegetative structure types, which are more indicative of younger, more open bosque habitat. Because of the existence of these characteristics, the South block has the lowest average fire frequency and, thus, seems to have fires occurring on a more frequent basis.

Overstory Vegetation Layer

The dominant species at all sites is the Rio Grande Cottonwood (*Populus deltoides*). Native trees such as Goodding's Willow (*Salix gooddingii*) and Box Elder (*Acer negundo*) are also important components of the overstory in the North and Middle blocks (Table 16). Canopy closure percentages and their variations show that the North block is older and has more overall canopy closure (Table 15). In the North block, the exotic trees, Siberian Elm (*Ulmus pumila*), Honey Locust (*Gleditsia triacanthos*) and White Mulberry (*Morus alba*) are growing into the overstory. The average canopy height for the older (~80 years of age) and larger trees was approximately 19 meters and average DBH (diameter-at-breast-height) was 50 centimeters. The other sites have younger and/or stunted trees (~40-50 years old), averaging 12-15 meters tall and 20-35 centimeters in diameter and have a higher number of trees per hectare. Some of these sites have higher Basal Area/HA than the older Structure I

sites (see Table 16). The sites in the North block are more homogeneous and show less variation in Basal Area and size than the Middle and South blocks (Table 15, 16).

Understory Vegetation Layer

The understory layer at all sites is dominated by exotic trees, the majority of which are Russian Olive and Salt Cedar (Table 17). The older understory in the North block is more robust in size and basal area when compared to other research blocks.

The number of Russian Olive trees per site showed a decrease along a north to south gradient (Table 17). Native species also showed a differentiation from north to south. New Mexico Olive (*Forestiera pubescens*), Seepwillow (*Baccharis salicifolia*) and Pale Wolfberry (*Lycium pallidum*) are much more prevalent in the South block. The two willows, Goodding's (*Salix gooddingii*) and Coyote (*Salix exigua*), are more abundant in the mesic Middle block. Rio Grande Seepwillow (*Baccharis salicina*) and Golden Current (*Ribes aureum*) are most prevalent in the North block (Table 17).

Ground Cover

Most of the results for the classes; Bare, Forb, Grass and Woody Debris were highly variable between sites, with sites in the South block having the most bare soil (Table 18). Percentage of litter increased as canopy closure increased. The highest overall percentage of canopy closure and the highest amount of ground litter was seen in the North block. Dominant ground species are listed, by site, in order of abundance in (Table 19).

The North block displayed a high proportion of the exotic forbs, Russian Knapweed (*Acroptilon repens*) and Kochia (*Kochia scoparia*). The Middle block has a higher relative abundance of sedges and rushes such as Three square sedge (*Schoenoplectus*

americanus) and Clustered field sedge (*Carex praegracilis*). The Middle block also has the largest number of the hydrophytic forb Yerba manza (*Anemopsis californica*).

Existing Snags

The older structure I sites (North block) tended to have the highest basal area and largest snags. The South block sites had lower overall basal areas with the exception of South 3, which had a large basal area of small snags. Standard deviation showed high variation within all research blocks.

Large, Dead and Down

A high amount of variation was observed between sites. As referred to earlier, the North block contained sites with older and larger trees and, therefore, had a higher number of snags and dead and down woody debris. The Prescription Guide for the Rio Grande Bosque (Appendix 1) recommends preserving 2-3 of the largest, soundest existing snags and downed logs (per acre) or ~ 8 per hectare. Five sites contained close to or less than the recommended number of large, dead and down logs. All should be retained during treatments.

Small, Dead and Down

There was high variation between sites in each block. Older Structure I sites consistently produced the highest numbers.

Fuels

At all study sites, with the exception of South 2, live exotics constituted the majority of total fuel loads (Table 24). Following the observed pattern, the North block's overall fuel load from dead and down was the highest of all the research blocks. Obviously, the

sites dominated by Salt Cedar (Table 16, 17) have the highest fire risk and, consequently, the shortest fire intervals.

Predictions of Short-term Treatment Effects

Removal of exotic shrubs at fuels reduction research sites will remove nest substrates for shrub nesting bird species, but may increase puddling and saturated soils. It may also alter evapotranspiration losses and increase surface / ground water quality. The removal of downed wood will remove foraging substrate for litter-foraging whiptails and nest cover for ground-nesters. A more open forest floor may, however, provide more substrate for sun-basking lizards. The removal of snags will remove nest and foraging substrates for cavity nesting birds and bats and, conversely, reduction of clutter will open corridors for bat travel and may enhance navigability and acoustic ability.

Products and Information/Technology Transfer

Progress reports have been delivered annually over the past three years to sponsors using sponsor report forms, including Joint Fire Sciences Program, National Fire Plan, and the RMRS Middle Rio Grande Ecosystem Management Research Program. In addition, oral presentations and posters focused on research findings have been given at the following conferences in the past 12 months: 2002 Southwest Fire Conference, San Diego, CA; 2002 International Ornithological Conference, Beijing, China; 2002 Middle Rio Grande Fire Meeting, Bosque del Apache National Wildlife Refuge, NM; 2002 RMRS Technical Assistance Visit Program Review, Albuquerque, NM, 2003 National Fire Plan Conference, New Orleans, LA, 2003 Joint Fire Science Program Workshop, Phoenix, AZ; 2003 Aquatic Ecosystems Conference, Las Cruces, NM, Arizona Riparian Council Meeting, Pinetop, AZ, 47th Annual Arizona Nevada

Academy of Science Meeting, Flagstaff, Arizona, and the 25th Annual New Mexico Rural Water Association Conference, Albuquerque, NM. Planned presentations for the remainder of 2003 include talks and posters at the September 2003 Annual Meeting of The Wildlife Society, Burlington VT and at the December 2003 International Wildlife Congress Meeting, Christchurch, New Zealand.

Additionally, RMRS presented information about this project in March 2003 to congressional staff in the New Mexico offices of Senator Dominici, Senator Bingaman, and Congressman Udall. Information has also been provided periodically to participants in the Middle Rio Grande ESA Collaborative Program, the Bosque Improvement Group, and other agencies and parties. MOU collaborators provided a field tour of North block fuel removal sites to a diverse audience as part of the RMRS Albuquerque Unit Review held in November 2002.

Future Research Priorities

The implementation of fuels reduction treatments along the Middle Rio Grande basin will affect hydrological features and the abundance and distribution of local flora and fauna. The collection of two to three years of baseline data (for all issues of concern) will provide a solid foundation for comparison of post-treatment site conditions.

The 2003 field season will include surveying of all sites following the standard protocols described in detail in this report. Post-treatment sampling (2004-2007) will be performed to determine short-term effects on flora, fauna, and hydrology. To evaluate long-term efficacy and impacts of treatments, monitoring will continue to be conducted in 5-year intervals.

Literature Cited

- Bibby, C. J., N. D. Burgess, and D. A. Hill. 1992. Bird Census Techniques. Academic Press, New York.
- Busch, D. E. and S. D. Smith. 1995. Mechanisms associated with decline of woody species in riparian ecosystems of the Southwestern U. S. *Ecological Monographs* 65 (3): 347-370.
- Enge, K. M. and W. R. Marion. 1986. Effects of clear cutting and site preparation on herpetofauna of a north Florida flatwoods. *Forest Ecology and Management* 14: 177-192.
- Fuels Management Analyst. 2002. Fire Program Solutions. www.fireps.com.
- James, F. C. and H. H. Shugart, Jr. 1970. A quantitative method of habitat description. *Audubon Field-Notes* 24: 727-736.
- Lanham, J. D. and D. C. Guynn. 1993. Influences of coarse woody debris in southern forests. Pages 101-107 in J. W. McMinn and D. A. Crossley, editors. Biodiversity and coarse woody debris in southern forests. General technical report SE-94. U. S. Forest Service, Southern Research Station, Asheville, North Carolina.
- Muldavin, E., P., P. Durkin, M. Bradley, M. Stuever, and P. Mehlhop. 2000. Handbook Of Wetland Vegetation Communities of New Mexico. New Mexico Natural Heritage Program, Biology Department, University of New Mexico, Albuquerque, New Mexico.
- Hink, V. C. and R. D. Ohmart. 1984. Middle Rio Grande Biological Survey, Final Report. Center for Environmental Studies, Arizona State University, Tempe, Arizona. In fulfillment of Army Corps of Engineers Contract No. DACW47-81-C-0015.
- Verner, J. 1985. An assessment of counting techniques. *Current Ornithology* 2: 247-302.
- Wicklund, C. P. and Y. Najmi. 1998. Prescription guide for the Rio Grande bosque, NM. NMEMNRD, State Forestry Division, Santa Fe, NM. 26 pages.
- Williams, B. K., J. D. Nichols, and M. J. Conroy. Analysis and Management of Animal Populations. 2002. Academic Press, San Diego, California.

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FIGURE 1.

FUELS REDUCTION STUDY ROCKY MOUNTAIN RESEARCH STATION

VICINITY MAP

- Mechanical clearing with Broadcast burn
- Mechanical clearing
- Mechanical clearing with Revegetation
- No Treatment
- Burned April 2002

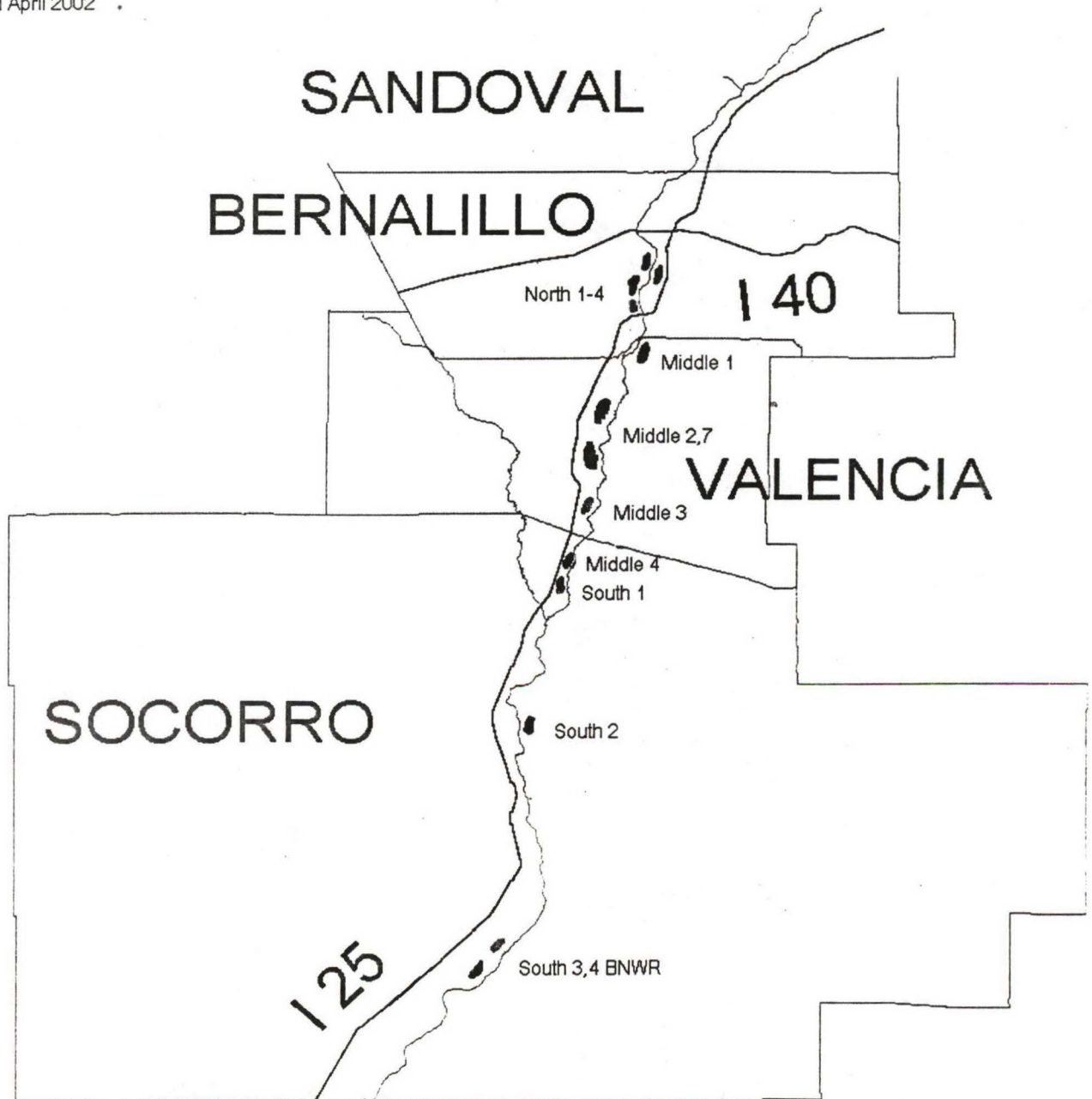


Figure 2.

FUELS REDUCTION STUDY SITES NORTH BLOCK

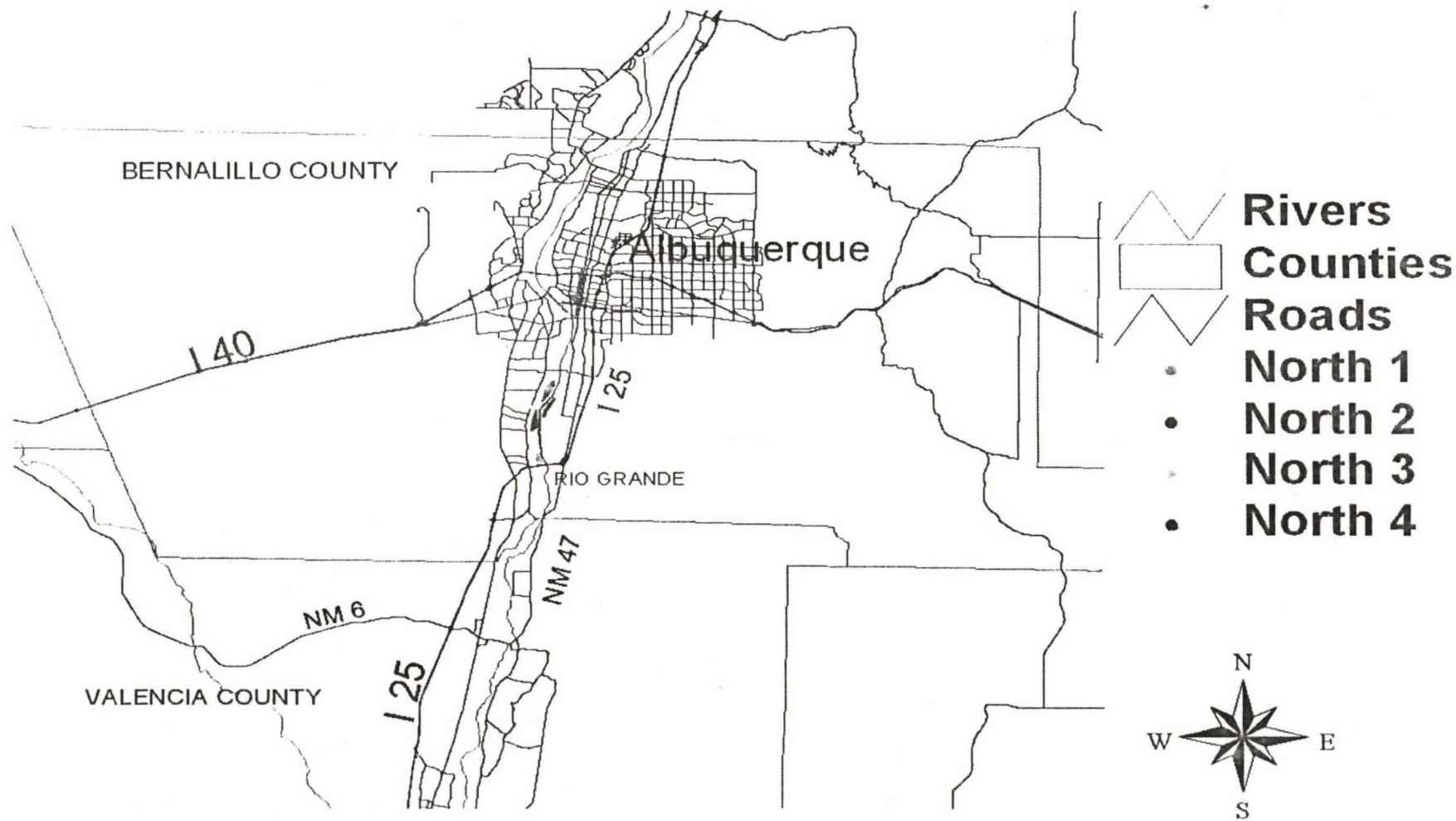


Figure 3.

FUELS REDUCTION STUDY SITES MIDDLE BLOCK

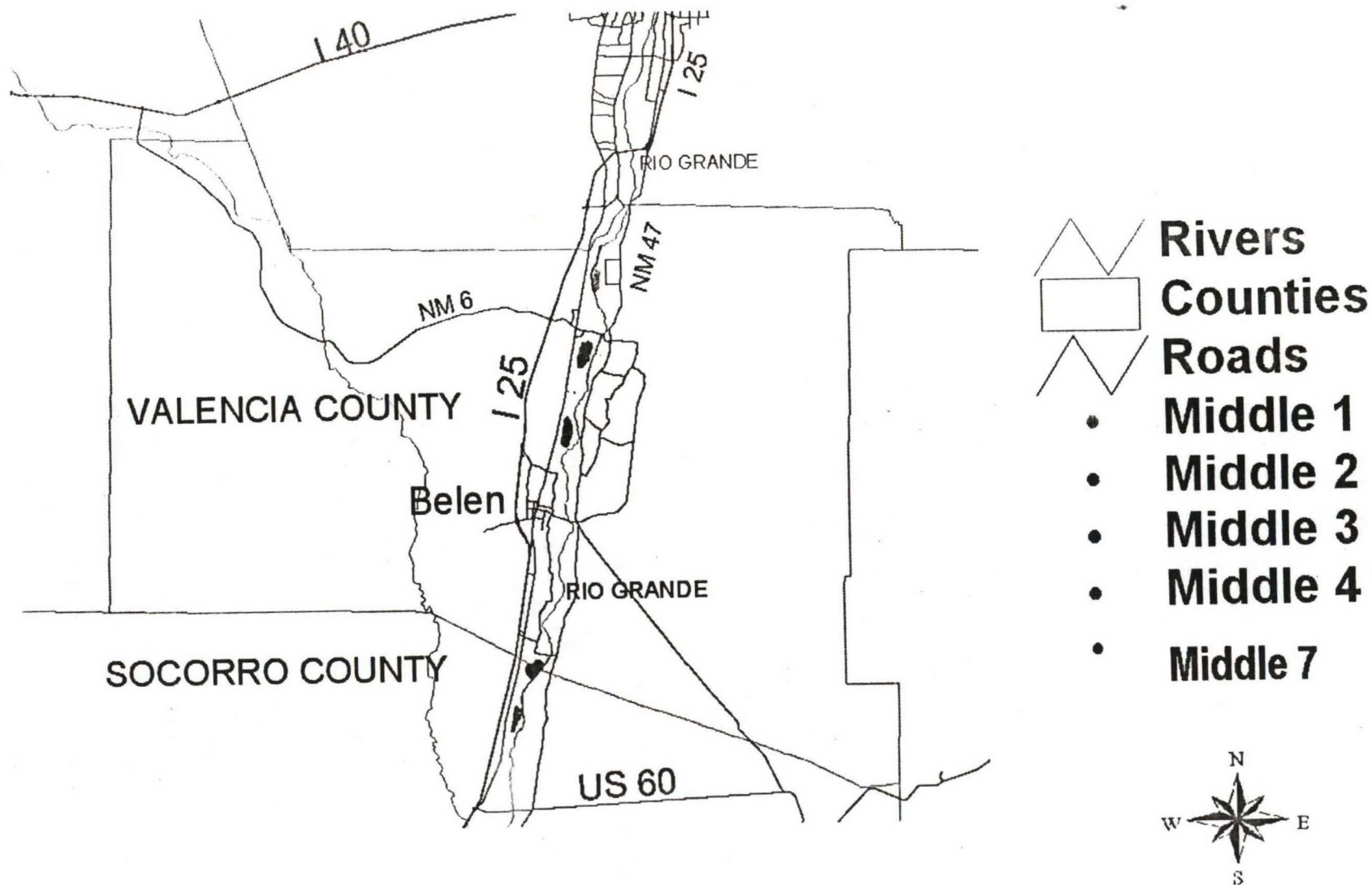
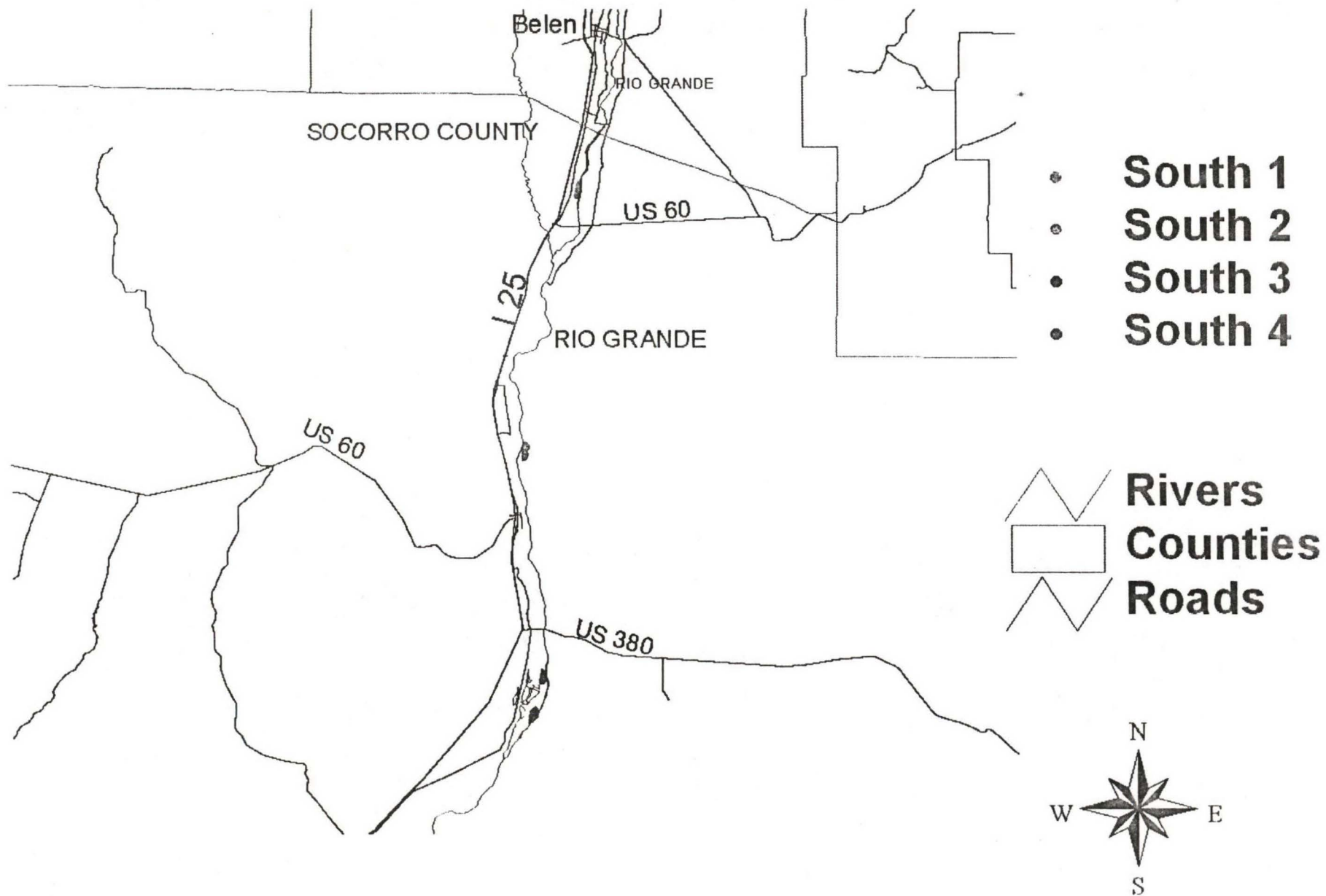


Figure 4.

FUELS REDUCTION STUDY SITES SOUTH BLOCK



Bosque del Apache NWR

Figure 5.

Fuels Reduction and Fire
Effects Studies Sites



- South 3
- South 4
- South 5
- South 6
- BNWR Management Areas
- LFCC-Rio Grande
- LFCC
- Rio Grande



Figure 6 Example Herp and Bat
Sampling Design

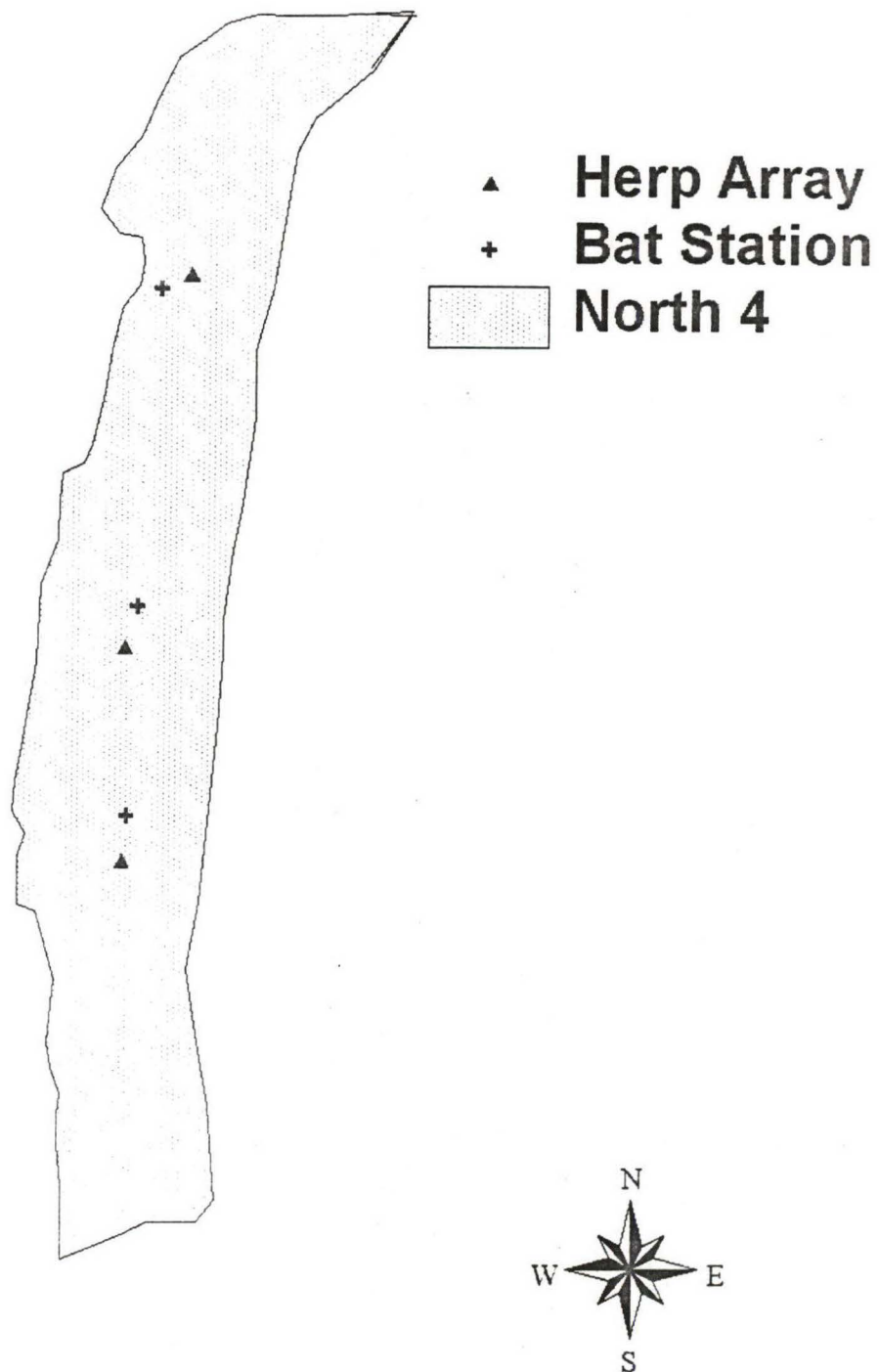


Figure 7 Example Bird and Vegetation Sampling Design

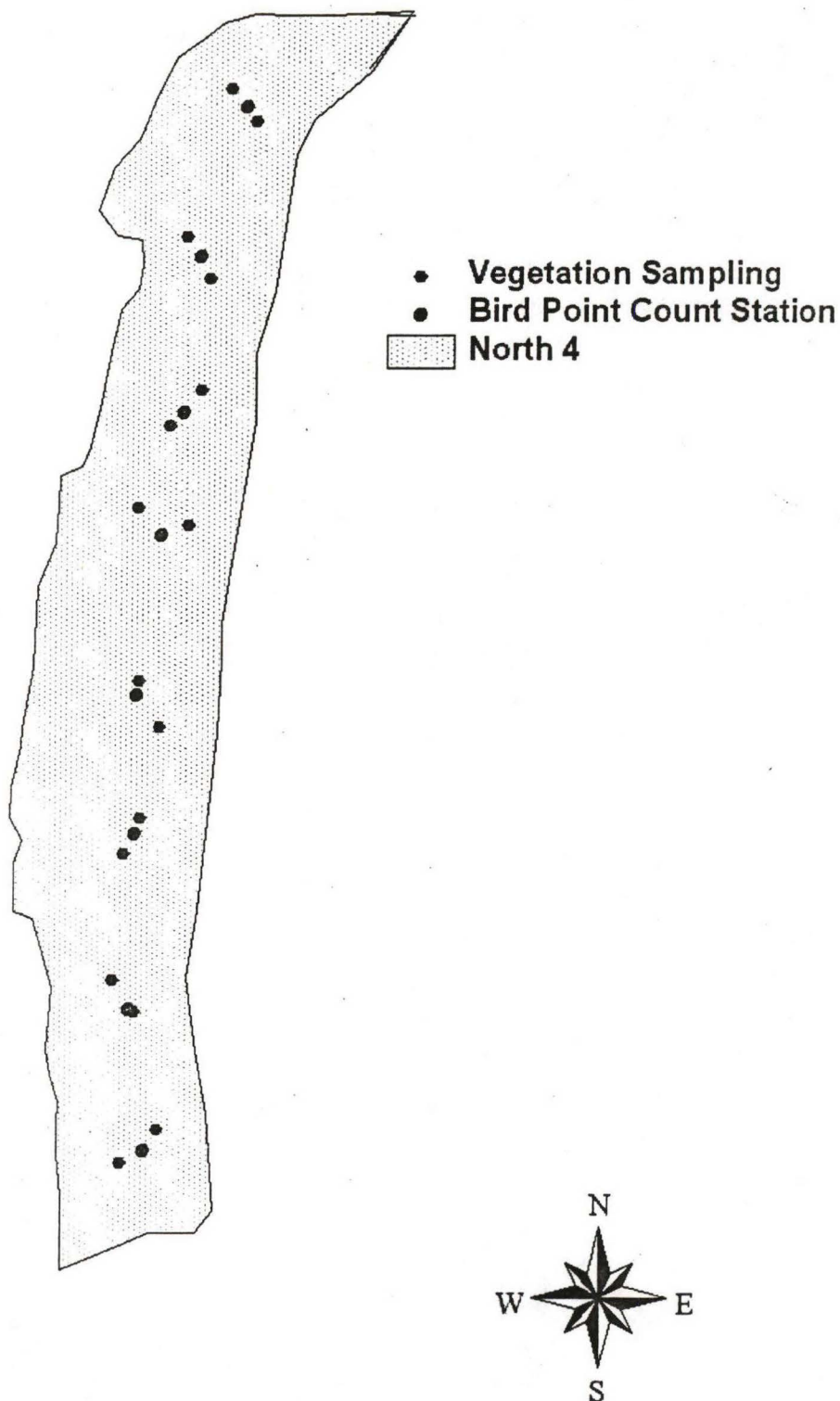
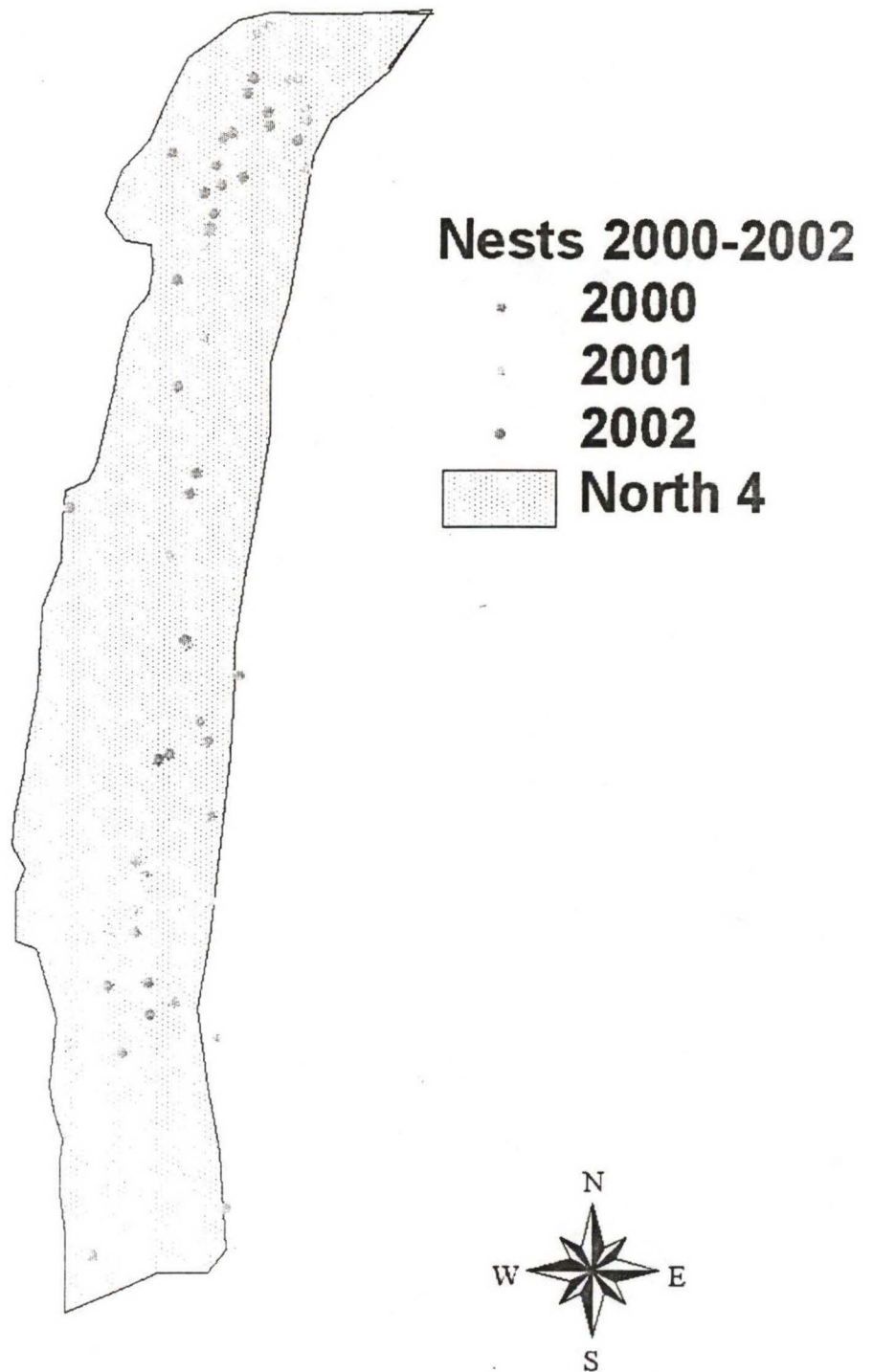


Figure 8 Example of Nest Locations



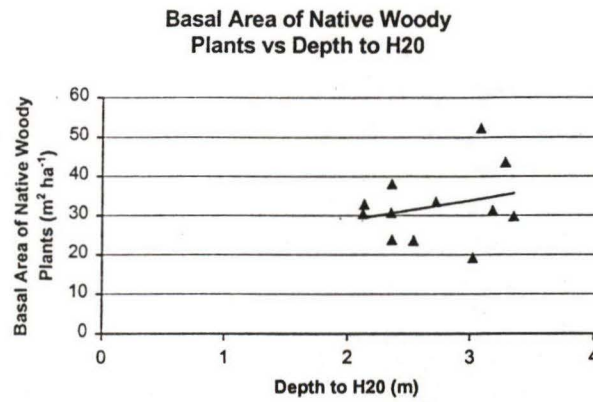
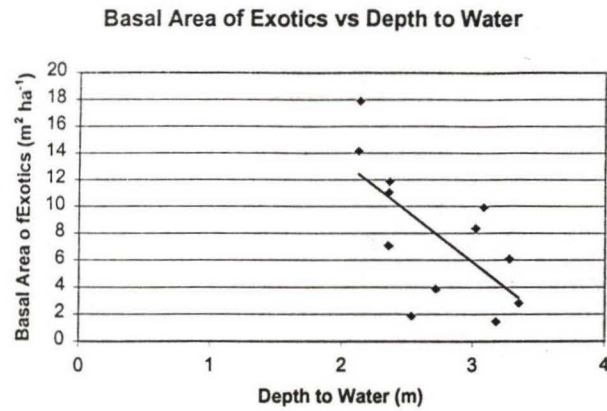


Figure 9. Plots of correlation between depth to water (m) and dead and down woody materials, live exotics, fuel bed depth, and basal area of exotic and native woody species.

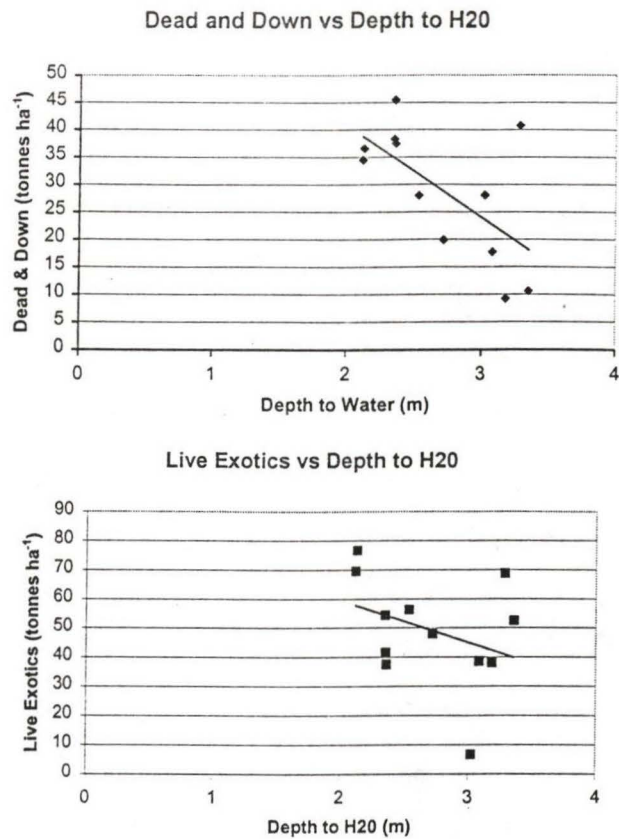


Figure 10. Plots of correlation between depth to water (m) and dead and down woody materials, live exotics, fuel bed depth, and basal area of exotic and native woody species.

Figure 11. Correlation between Black-chinned Hummingbirds and abundance of Russian Olive (2000-2001).

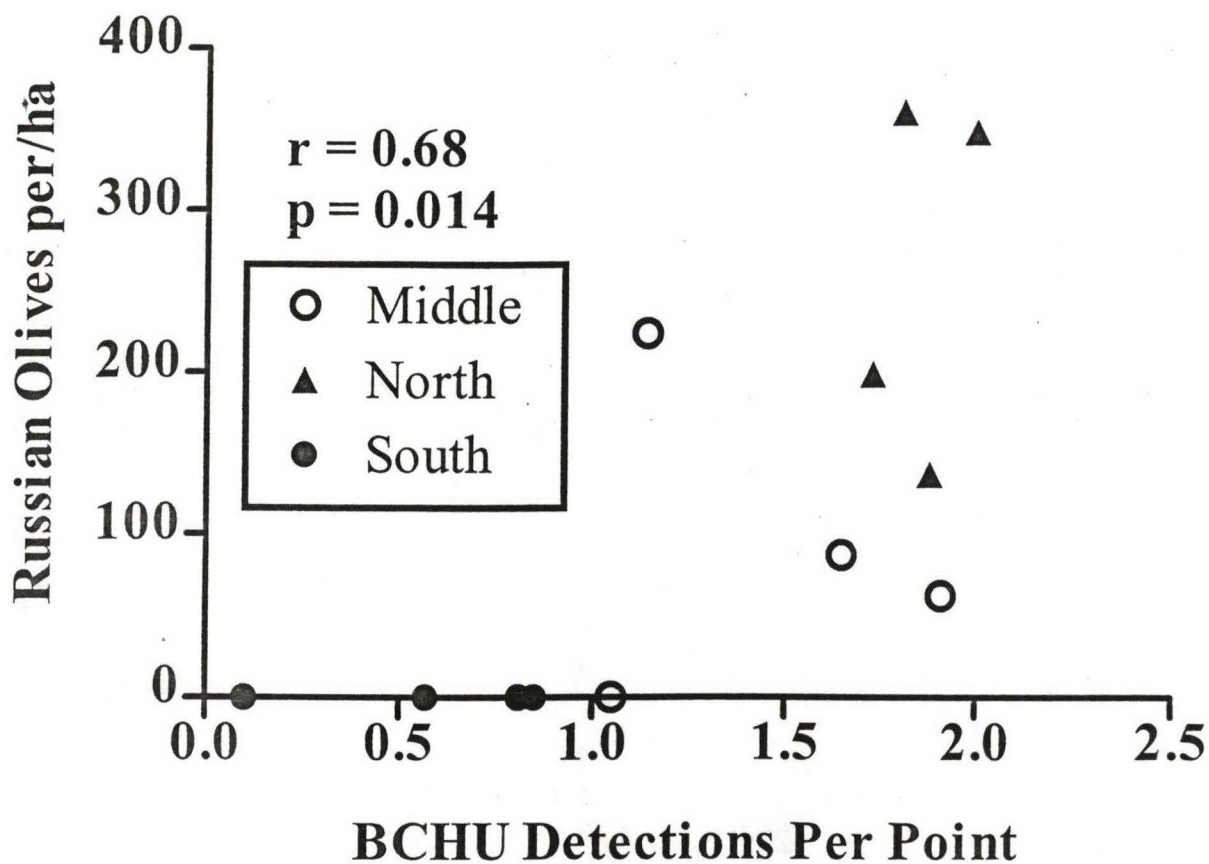


Figure 12. Use of native and exotic plants by common avian species

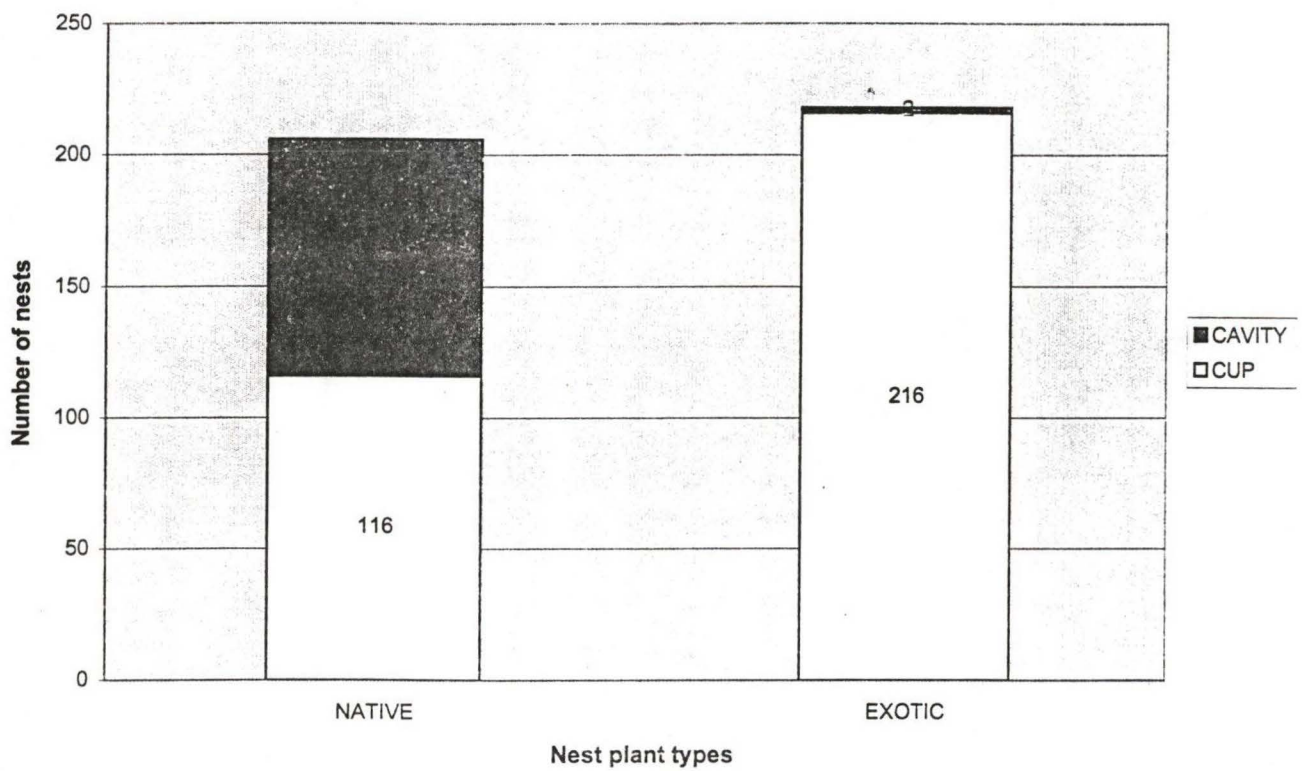


Figure 13. Correlation between canopy cover (%) and rate of detection of Black-chinned Hummingbirds (2000-2001).

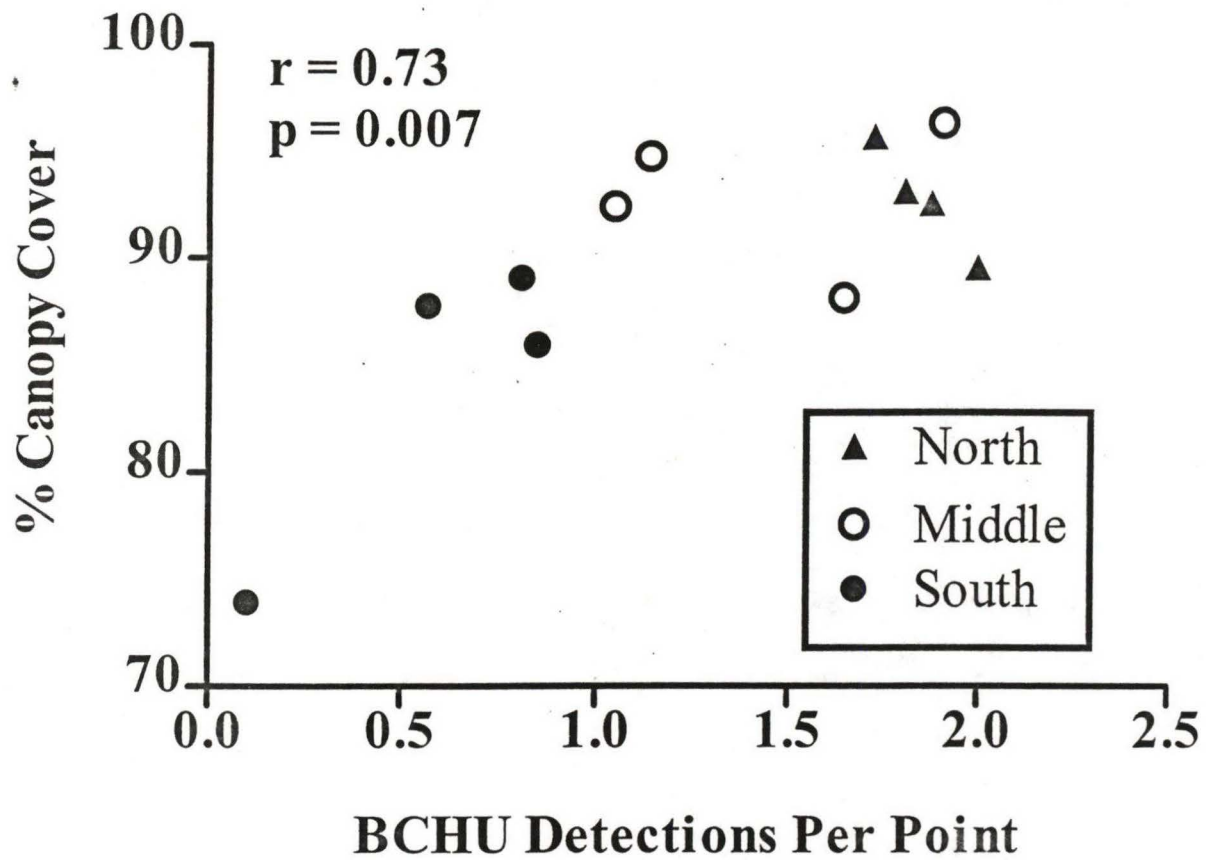


Figure 14. Relationship between number of nests and nest height (m) (2000-2001).

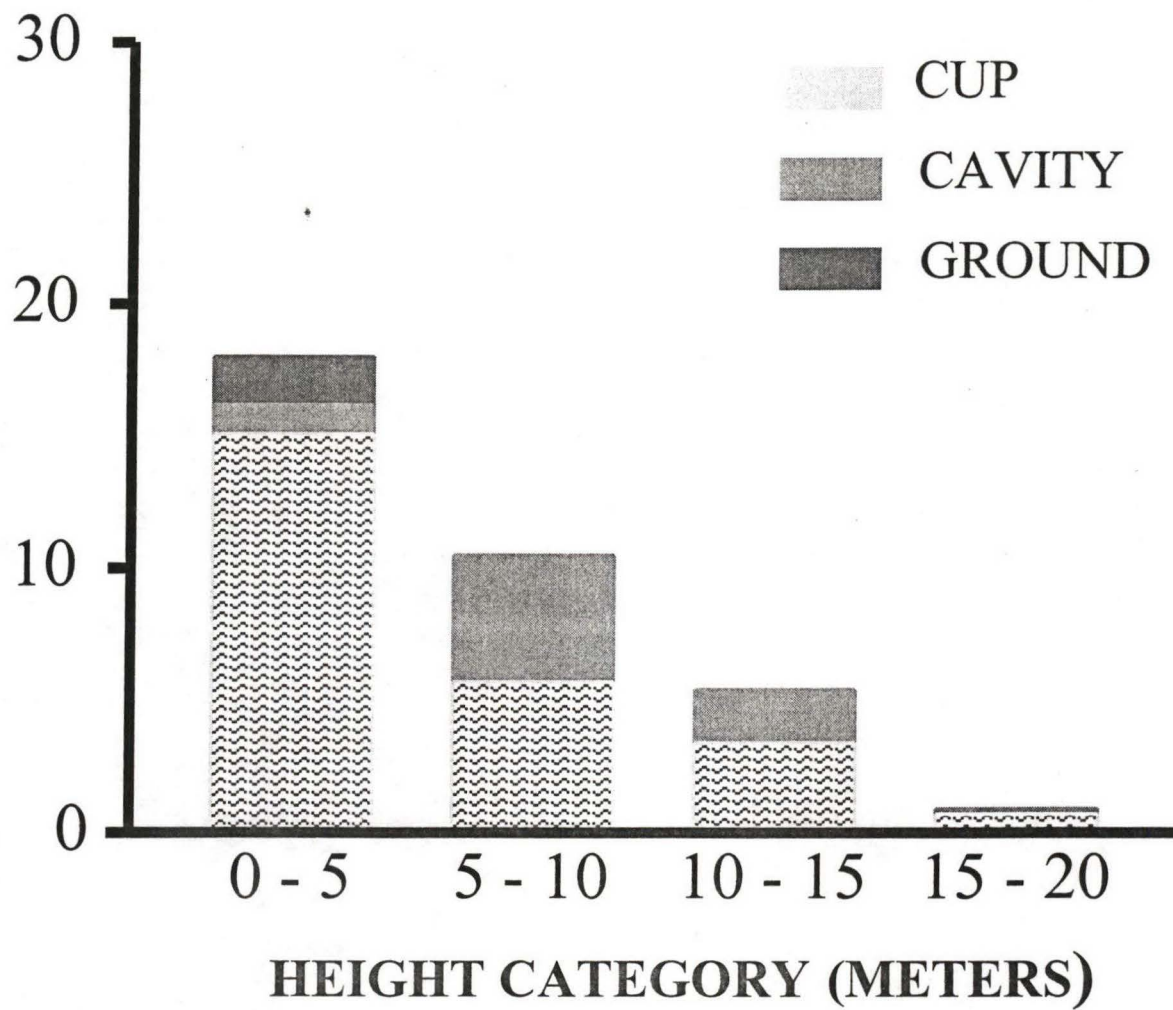


Figure 15. Positive correlation between abundance of Bewick's Wrens during breeding season surveys (2000-2001) and presence of logs 20 cm or greater (dbh).

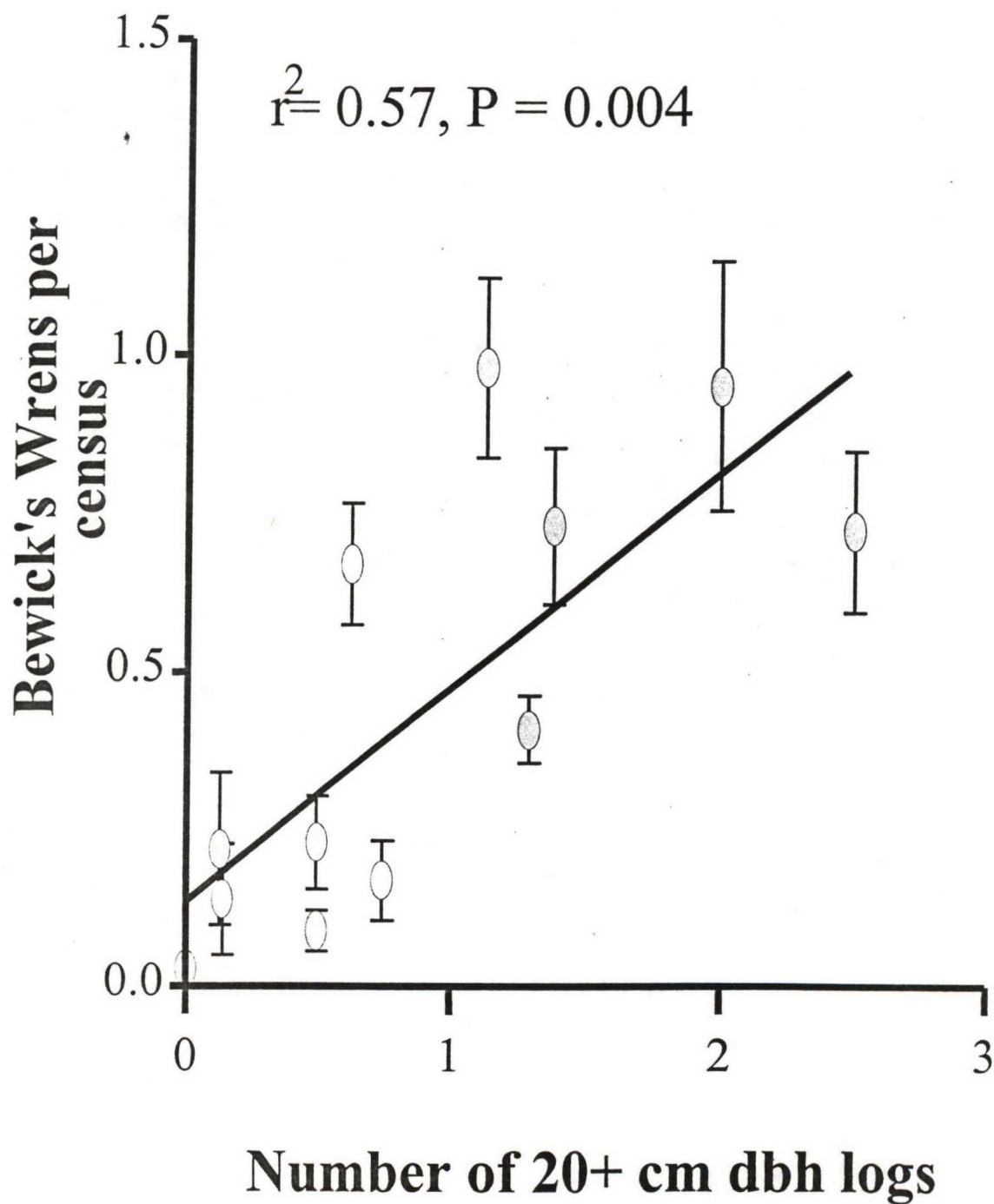


Figure 16.
Fire Effects Study
Middle Block

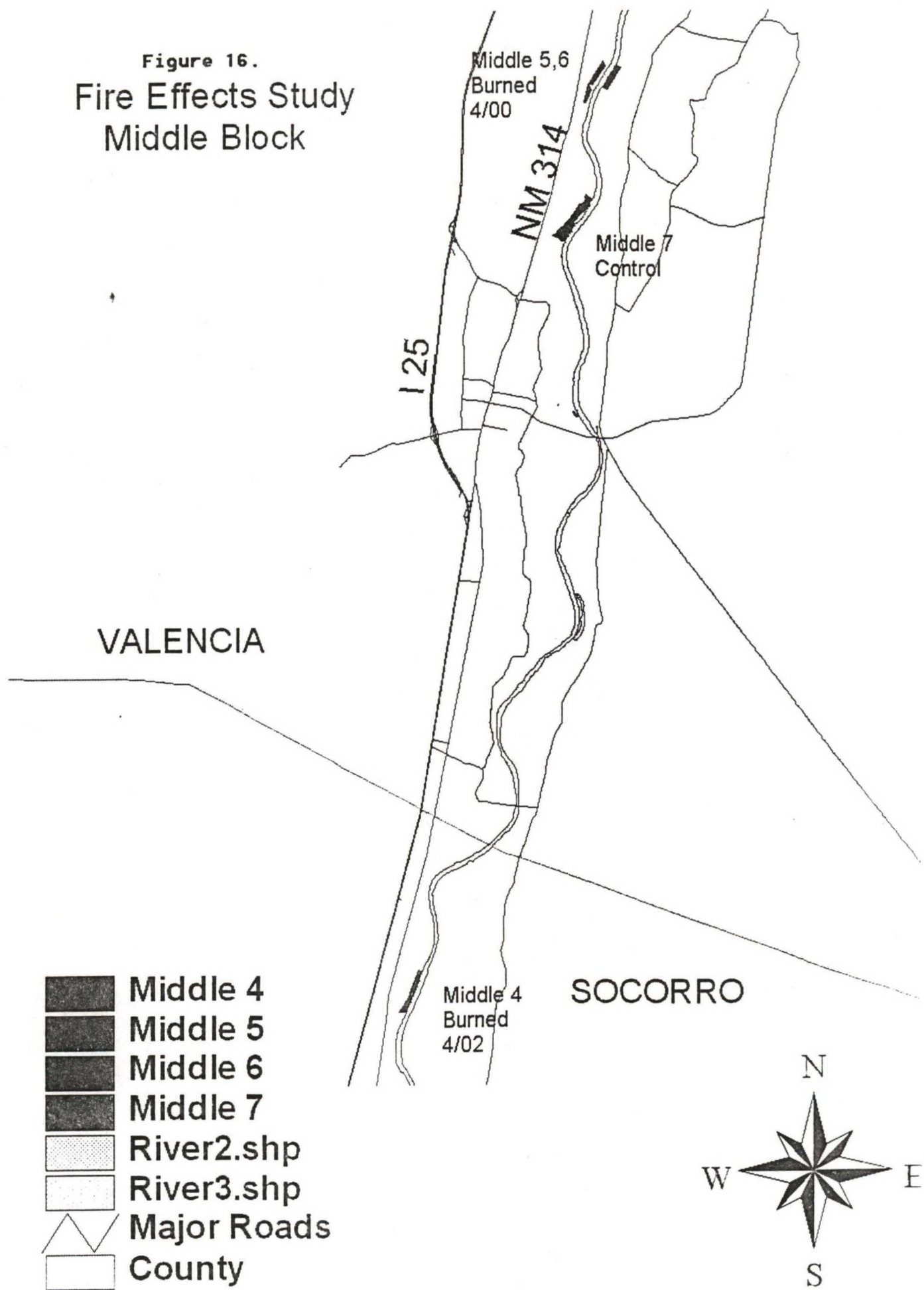
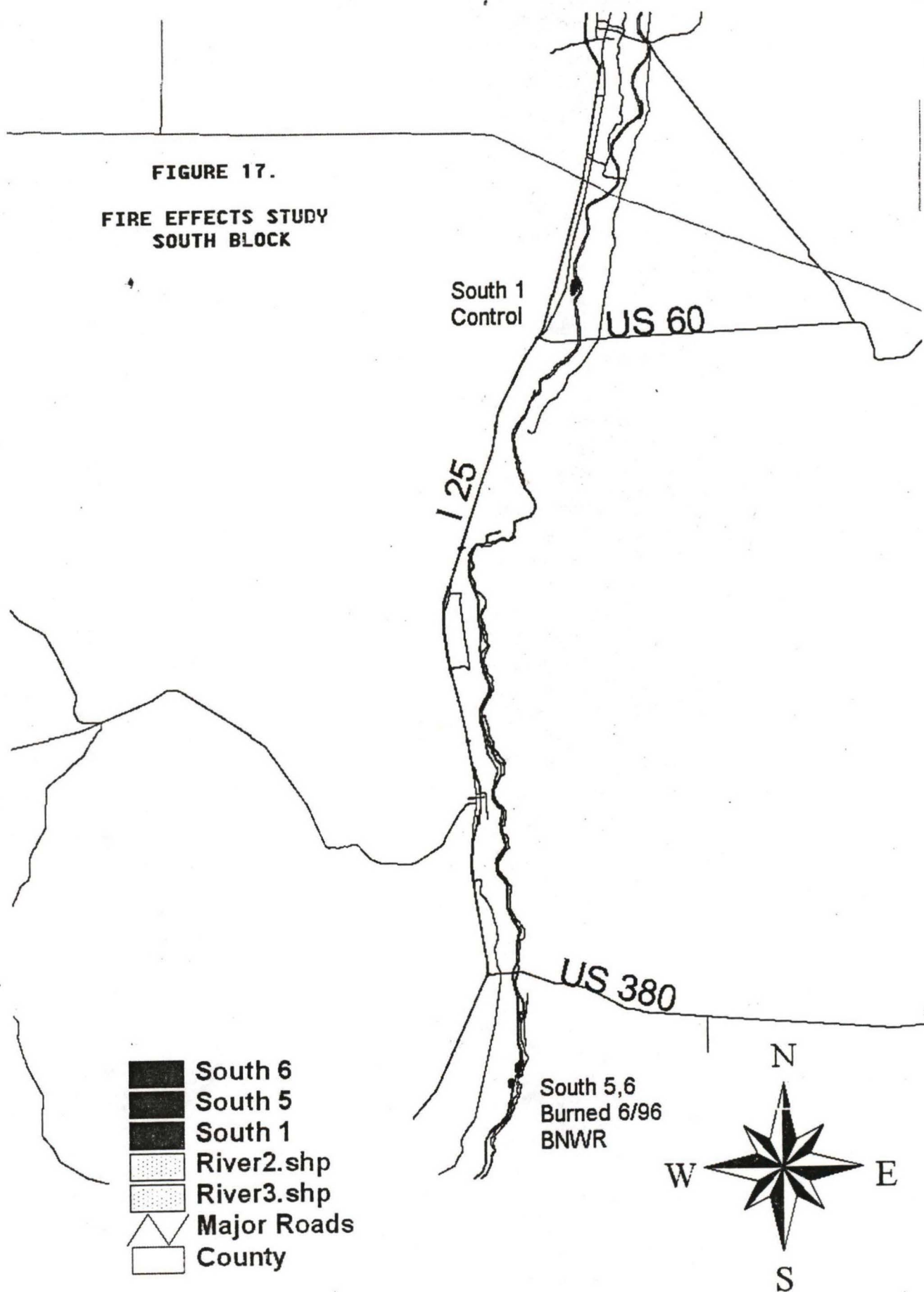


FIGURE 17.

**FIRE EFFECTS STUDY
SOUTH BLOCK**



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Table 1. Site Descriptions

Block	Site Name	Land Manager	Hectares	Habitat	Location and Relation to River
NORTH	NORTH 1	Albq,MRGCD,NMSP	16.07	Riparian Cottonwood Gallery	S Rio Bravo 1 mi-N I25 westside
	NORTH 2	Albq,MRGCD,NMSP	21.01	Riparian Cottonwood Gallery	S Rio Bravo 2 mi-N I25 westside
	NORTH 3	Albq,MRGCD,NMSP	16.30	Riparian Cottonwood Gallery	S Rio Bravo 5 mi-N I25 westside
	NORTH 4	Albq,MRGCD,NMSP	23.43	Riparian Cottonwood Gallery	S Rio Bravo 1.5 mi-N I25 eastside
NORTH	all		76.81		
MIDDLE	MIDDLE 1	MRGCD	19.84	Riparian Cottonwood Gallery	N NM6 4.5 mi S Isleta Pueblo eastside
	MIDDLE 2	MRGCD	29.17	Riparian Cottonwood Gallery	S NM6 1 mi S Los Lunas westside
	MIDDLE 3	MRGCD	13.03	Riparian Cottonwood Gallery	S NM346 1 mi westside
	MIDDLE 4A	MRGCD	9.48	Riparian Cottonwood Gallery	N US60 4 mi E Bernado westside
	MIDDLE 7	MRGCD	35.00	Riparian Cottonwood Gallery	S NM6 S Los Chaves 1.5 mi westside
MIDDLE	all		106.52		
SOUTH	SOUTH 1	MRGCD	28.87	Riparian Cottonwood Gallery	N US60 3 mi E Abeytas westside
	SOUTH 2	MRGCD	15.54	Riparian Cottonwood Gallery	E Lemitar eastside
	SOUTH 3	USFWS	26.71	Riparian Cottonwood Gallery	S .5 mi N refuge boundary W LFCC
	SOUTH 4	USFWS	15.45	Riparian Cottonwood Gallery	S 3 mi SO3 W LFCC
SOUTH	all		86.57		
FIRE EFFECTS	MIDDLE 4B	MRGCD	9.30	Burned 2002 Riparian Cottonwood	N US60 4 mi E Bernado westside
	MIDDLE 5	MRGCD	15.00	Burned 2000 Riparian Cottonwood	S NM6 3.25 mi. westside
	MIDDLE 6	MRGCD	16.44	Burned 2000 Riparian Cottonwood	S NM6 3.0 mi. eastside
	SOUTH 5	USFWS	7.66	Burned 1996 Riparian Cottonwood	1 MI. N SO4 W of LFCC
	SOUTH 6	USFWS	14.44	Burned 1996 Riparian Cottonwood	.5 MI. S SO3 E of LFCC westside
FIRE EFFECTS	all		53.54		

Table 2. Summary of study site locations, management, treatments, and depth to water.

Block & Site	Management Agencies*	Location	Treatment*	Area (ha)	Depth To Water (m)		
					Avg.	Min.	Max.
North 1	MRGCD, NMSP, COA	Rio Grande Valley State Park	D	16.07	2.36	2.06	2.52
North 2	MRGCD, NMSP, COA	Rio Grande Valley State Park	C	21.01	2.12	1.87	2.24
North 3	MRGCD, NMSP, COA	Rio Grande Valley State Park	A	16.30	2.13	1.88	2.25
North 4	MRGCD, NMSP, COA	Rio Grande Valley State Park	B	24.34	2.36	2.06	2.52
Middle 1	MRGCD	Los Lunas	A	19.84	2.72	2.56	2.83
Middle 2	MRGCD	Los Lunas	B	29.17	3.18	3.03	3.33
Middle 3	MRGCD	Bosque	C	13.03	2.35	2.09	2.78
Middle 4	MRGCD	Bernardo	D	18.78	3.08	2.73	3.47
South 1	MRGCD	Bernardo	D	28.87	3.35	3.23	3.64
South 2	MRGCD, BLM	Lemitar	C	15.54	3.02	2.72	3.42
South 3	USFWS	Bosque del Apache	B	26.71	3.28	3.03	3.61
South 4	USFWS	Bosque del Apache	A	15.26	2.54	1.58	3.01

*Management Agencies: COA (City of Albuquerque); MRGCD (Middle Rio Grande Conservancy District; NMSP (New Mexico State Parks); BLM (Bureau of Land Management; and USFWS (US Fish and Wildlife Service).

*Treatments:

A = Removal of dead, down & exotic woody species.

B = Removal of dead, down & exotic woody species, followed by fire treatment.

C = Removal of dead, down & exotic woody species, followed by revegetation with native species.

D = Control.

Table 3. Summary of vegetation and fuel load data collected with fixed and variable plots and line transects.

Block/Site	Avg. Depth to H2O (m)	Fuel Load (tonnes ha ⁻¹)		Fuel Bed Depth (cm)	Basal Area (m ² ha ⁻¹)	
		Dead & Down	Live Exotics		Exotic	Native
North 1	2.36	45.53	41.81	23.55	11.06	38.11
North 2	2.12	34.52	69.82	15.39	14.17	30.48
North 3	2.13	36.58	76.88	20.93	17.90	32.89
North 4	2.36	37.48	37.75	51.54	11.89	23.84
Middle 1	2.72	19.94	48.29	5.33	3.89	33.50
Middle 2	3.18	9.31	38.31	2.39	1.47	31.31
Middle 3	2.35	38.31	54.68	9.53	7.09	30.72
Middle 4	3.08	17.79	38.80	7.14	9.92	52.36
South 1	3.35	10.65	52.71	4.39	2.82	29.84
South 2	3.02	28.10	6.84	9.47	8.35	19.31
South 3	3.28	40.86	69.01	19.69	6.10	43.55
South 4	2.54	28.01	56.50	14.66	1.89	23.64

Table 4 . A comparison of relative bat activity between years at each site. Relative bat activity is the average number of echolocation call files per night.

SITE	2001			2002			P-value
	N	Mean	SE	N	Mean	SE	
NO1	3	17.07	10.98	3	13.80	3.49	0.79
NO2	3	12.98	6.30	3	10.57	5.09	0.78
NO3	3	24.10	15.45	3	60.92	44.57	0.48
NO4	3	18.49	10.20	3	36.07	15.29	0.39
MI1	3	4.41	1.30	3	16.37	1.58	0.00
MI2*	3	4.21	3.09	3	16.73	7.85	0.21
MI3	3	13.52	2.89	3	30.31	8.03	0.12
MI4	3	2.86	1.81	3	8.27	3.61	0.25
SO1	3	16.20	9.22	3	21.45	5.99	0.66
SO2	3	41.14	9.64	3	47.12	15.19	0.76
SO3	3	56.64	23.28	3	56.82	17.72	1.00
SO4	3	172.00	23.72	3	220.19	33.97	0.31

Table 5. Herpetofauna captures in drift fence arrays. Total number of captures and number of sites at which species were captured.

Genus	species	captures	sites
<i>Sceloporus</i>	<i>undulatus</i>	2019	10
<i>Cnemidophorus</i>	<i>neomexicanus</i>	1746	12
<i>Cnemidophorus</i>	<i>exsanguis</i>	1538	12
<i>Cnemidophorus</i>	<i>uniparens</i>	876	6
<i>Bufo</i>	<i>woodhousii</i>	572	12
<i>Eumeces</i>	<i>obsoletus</i>	282	11
<i>Sceloporus</i>	<i>magister</i>	47	1
<i>Scaphiopus</i>	<i>couchii</i>	34	6
<i>Cnemidophorus</i>	<i>tigris</i>	27	1
<i>Uta</i>	<i>stansburiana</i>	18	2
<i>Lampropeltis</i>	<i>getula</i>	17	5
<i>Bufo</i>	<i>cognatus</i>	17	3
<i>Cnemidophorus</i>	<i>spp</i>	15	7
<i>Spea</i>	<i>multiplicata</i>	11	7
<i>Cnemidophorus</i>	<i>tesselatus</i>	10	2
<i>Thamnophis</i>	<i>sirtalis</i>	7	4
<i>Pituophis</i>	<i>melanoleucus</i>	6	5
<i>Heterodon</i>	<i>nasicus</i>	6	3
<i>Tantilla</i>	<i>nigriceps</i>	5	3
<i>Thamnophis</i>	<i>spp</i>	3	2
<i>Ambystoma</i>	<i>tigrinum</i>	2	2
<i>Masticophis</i>	<i>flagellum</i>	2	2
<i>Spea</i>	<i>bombifrons</i>	2	2
<i>Rana</i>	<i>catesbiana</i>	2	1
<i>Thamnophis</i>	<i>elegans</i>	2	1
<i>Bufo</i>	<i>spp</i>	1	1
<i>Cnemidophorus</i>	<i>inornatus</i>	1	1
<i>Leptotyphlops</i>	<i>dulcis</i>	1	1
<i>Phrynosoma</i>	<i>cornutum</i>	1	1
<i>Pseudacris</i>	<i>triseriata</i>	1	1
<i>Rhinocheilus</i>	<i>lecontei</i>	1	1
<i>Thamnophis</i>	<i>marcianus</i>	1	1
Total		7277	

Table 6. Small mammal captures in drift fence arrays. Total number of captures and number of sites at which species were captured.

Genus	species	captures	Sites
<i>Notiosorex</i>	<i>crawfordii</i>	992	12
<i>Peromyscus</i>	<i>spp</i>	121	12
<i>Thomomys</i>	<i>bottae</i>	7	5
<i>Mus</i>	<i>musculus</i>	4	2
<i>Peromyscus</i>	<i>maniculatus</i>	4	2
<i>Neotoma</i>	<i>spp</i>	3	1
<i>Reithrodontomys</i>	<i>megalotis</i>	3	2
<i>Spermophilus</i>	<i>variegatus</i>	2	1
<i>Mustela</i>	<i>frenata</i>	1	1
<i>Neotoma</i>	<i>lepida</i>	1	1
<i>Onychomys</i>	<i>leucogaster</i>	1	1
Total		1135	

Table 7. Common Nesting Species on Breeding Season Surveys 2000-2002
(detections per 100 survey minutes)

	NO1	NO2	NO3	NO4	MI1	MI2	MI3	MI4/7	SO1	SO2	SO3	SO4
Cooper's Hawk (<i>Accipiter cooperii</i>)	2.66	1.89	0.63	1.25	2.86	0.66	2.55	1.91	0.55	1.31	0.39	0.08
American Kestrel (<i>Falco sparverius</i>)	0.31	0.08	0.18	0.31	0.00	0.33	0.49	0.52	0.08	2.02	0.00	0.70
Mourning Dove (<i>Zenaida macroura</i>)	3.36	4.19	5.71	8.20	2.95	9.62	9.38	7.38	11.56	12.62	9.06	12.42
Yellow-billed Cuckoo (<i>Coccyzus americanus</i>)	0.08	0.49	0.18	0.08	0.09	0.00	0.16	0.43	0.31	0.36	1.88	1.09
Black-chinned Hummingbird (<i>Archilochus alexandri</i>)	23.05	26.97	27.99	24.45	24.55	26.81	16.94	18.32	10.63	11.31	6.41	1.80
Downy Woodpecker (<i>Picoides pubescens</i>)	3.05	1.32	1.09	3.20	2.59	2.63	1.48	1.04	1.25	0.71	0.94	0.78
Northern Flicker (<i>Colaptes auratus</i>)	2.11	3.04	5.34	1.48	2.50	3.70	3.70	2.69	1.56	5.71	0.78	4.45
Western Wood-Pewee (<i>Contopus sordidulus</i>)	1.95	0.99	7.70	5.86	1.07	2.63	4.36	1.39	8.28	4.05	1.48	2.66
Ash-throated Flycatcher (<i>Myiarchus cinerascens</i>)	5.08	3.62	3.89	4.61	5.00	17.60	6.41	7.03	16.33	11.55	8.91	17.81
Black-capped Chickadee (<i>Poecile atricapilla</i>)	6.41	4.19	5.43	2.81	7.59	8.14	2.80	2.34	1.09	0.00	0.08	0.00
White-breasted Nuthatch (<i>Sitta carolinensis</i>)	5.63	4.93	4.17	5.78	3.39	4.85	3.13	1.13	1.72	3.33	0.55	0.63
Bewick's Wren (<i>Thryomanes bewickii</i>)	8.75	10.94	9.33	13.13	5.00	5.35	4.52	3.73	5.23	11.67	8.05	19.45
Phainopepla (<i>Phainopepla nitens</i>)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.60	0.23	0.08
Yellow-breasted Chat (<i>Icteria virens</i>)	7.11	8.55	6.07	3.98	5.98	5.35	9.79	5.82	9.14	21.31	11.56	9.61
Summer Tanager (<i>Piranga rubra</i>)	4.14	4.61	5.16	6.33	5.36	6.25	4.19	6.34	6.33	8.81	6.88	8.67
Spotted Towhee (<i>Pipilo maculatus</i>)	10.86	18.09	16.21	17.19	13.39	17.11	11.68	16.06	14.45	21.79	13.67	13.67
Black-headed Grosbeak (<i>Pheucticus melanocephalus</i>)	10.94	16.28	15.13	20.31	18.84	14.64	12.42	13.54	20.47	10.60	9.45	6.25
Blue Grosbeak (<i>Passerina caerulea</i>)	5.70	4.03	4.44	2.81	4.02	6.00	7.73	9.46	11.88	10.48	7.81	5.47
Brown-headed Cowbird (<i>Molothrus ater</i>)	4.14	4.28	5.07	6.95	6.43	10.36	7.48	9.98	16.72	12.62	9.61	15.23
Lesser Goldfinch (<i>Carduelis psaltria</i>)	1.25	0.58	2.63	1.72	0.63	1.64	3.54	1.82	1.02	0.95	4.06	2.03

Table 8. Additional Species Detected on Breeding Season Surveys 2000-2002
(detections per 100 survey minutes)

SPECIES	2000	2001	2002	SPECIES	2000	2001	2002
Pied-billed Grebe (<i>Podilymbus podiceps</i>)	0.02	0.02	0.02	Northern Rough-winged Swallow (<i>Stelgidopteryx serripennis</i>)	0.02	0.12	0.12
Double-crested Cormorant (<i>Phalacrocorax auritus</i>)	0.02	0.00	0.07	Bank Swallow (<i>Riparia riparia</i>)	0.07	0.02	0.00
Great Blue Heron (<i>Ardea herodias</i>)	0.11	0.05	0.14	Cliff Swallow (<i>Hirundo pyrrhonota</i>)	0.11	0.07	0.32
Great Egret (<i>Ardea alba</i>)	0.00	0.02	0.12	Barn Swallow (<i>Hirundo rustica</i>)	0.16	0.14	0.76
Snowy Egret (<i>Egretta thula</i>)	0.12	0.07	0.09	Mountain Chickadee (<i>Parus gambeli</i>)	0.00	0.02	0.00
Cattle Egret (<i>Bubulcus ibis</i>)	0.00	0.16	0.00	Verdin (<i>Auriparus flaviceps</i>)	0.18	0.02	0.02
Green Heron (<i>Butorides virescens</i>)	0.02	0.02	0.00	Bushtit (<i>Psaltirparus minimus</i>)	0.30	0.09	1.16
Black-crowned Night-Heron (<i>Nycticorax nycticorax</i>)	0.07	0.02	0.30	Red-breasted Nuthatch (<i>Sitta canadensis</i>)	0.00	0.00	0.02
Turkey Vulture (<i>Cathartes aura</i>)	0.16	0.07	0.95	Marsh Wren (<i>Cistothorus palustris</i>)	0.00	0.00	0.02
Canada Goose (<i>Branta canadensis</i>)	0.60	0.30	1.06	Ruby-crowned Kinglet (<i>Regulus calendula</i>)	0.00	0.02	0.00
Wood Duck (<i>Aix sponsa</i>)	0.02	0.02	0.28	Eastern Bluebird (<i>Sialia sialis</i>)	0.02	0.00	0.00
Mallard (<i>Anas platyrhynchos</i>)	1.92	1.07	2.48	Swainson's Thrush (<i>Catharus ustulatus</i>)	0.00	0.00	0.02
Green-winged Teal (<i>Anas crecca</i>)	0.00	0.00	0.05	Hermit Thrush (<i>Catharus guttatus</i>)	0.00	0.05	0.00
Red-tailed Hawk (<i>Buteo jamaicensis</i>)	0.04	0.00	0.00	American Robin (<i>Turdus migratorius</i>)	0.82	0.28	0.72
Ring-necked Pheasant (<i>Phasianus colchicus</i>)	3.76	3.18	6.06	Gray Catbird (<i>Dumetella carolinensis</i>)	0.28	0.19	0.37
Wild Turkey (<i>Meleagris gallopavo</i>)	0.18	0.19	0.14	Northern Mockingbird (<i>Mimus polyglottos</i>)	0.23	0.00	0.51
Gambel's Quail (<i>Callipepla gambelii</i>)	0.53	0.28	0.69	European Starling (<i>Sturnus vulgaris</i>)	0.04	0.00	0.19
American Coot (<i>Fulica americana</i>)	0.00	0.05	0.30	Orange-crowned Warbler (<i>Vermivora celata</i>)	0.00	0.02	0.07
Killdeer (<i>Charadrius vociferus</i>)	0.39	0.12	0.44	Virginia's Warbler (<i>Vermivora virginiae</i>)	0.05	0.02	0.05
Spotted Sandpiper (<i>Actitis macularia</i>)	0.11	0.05	0.37	Lucy's Warbler (<i>Vermivora luciae</i>)	0.44	0.74	0.88
Wilson's Snipe (<i>Gallinago delicata</i>)	0.00	0.00	0.02	Yellow Warbler (<i>Dendroica petechia</i>)	0.00	0.23	0.21
Ring-billed Gull (<i>Larus delawarensis</i>)	0.00	0.00	0.02	Yellow-rumped Warbler (<i>Dendroica coronata</i>)	0.00	0.44	0.14
Rock Dove (<i>Columba livia</i>)	0.55	0.14	0.00	Prothonotary Warbler (<i>Protonotaria citrea</i>)	0.00	0.00	0.02
White-winged Dove (<i>Zenaidura macroura</i>)	0.05	0.30	0.19	Ovenbird (<i>Seiurus aurocapillus</i>)	0.00	0.00	0.02
Greater Roadrunner (<i>Geococcyx californianus</i>)	0.27	0.14	0.51	Kentucky Warbler (<i>Oporornis formosus</i>)	0.00	0.02	0.00
Western Screech-Owl (<i>Otus kennicottii</i>)	0.00	0.00	0.02	MacGillivray's Warbler (<i>Oporornis tolmiei</i>)	0.02	0.05	0.07
Great Horned Owl (<i>Bubo virginianus</i>)	0.09	0.09	0.23	Common Yellowthroat (<i>Geothlypis trichas</i>)	0.57	0.44	1.25
Common Nighthawk (<i>Chordeiles minor</i>)	0.04	0.00	0.05	Wilson's Warbler (<i>Wilsonia pusilla</i>)	0.02	0.16	0.35
Broad-tailed Hummingbird (<i>Selasphorus platycercus</i>)	0.04	0.09	0.07	Western Tanager (<i>Piranga ludoviciana</i>)	0.02	0.16	0.37
Belted Kingfisher (<i>Ceryle alcyon</i>)	0.05	0.02	0.02	Chipping Sparrow (<i>Spizella passerina</i>)	0.02	0.05	0.02
Ladder-backed Woodpecker (<i>Picoides scalaris</i>)	0.43	0.23	0.32	Lark Sparrow (<i>Chondestes grammacus</i>)	0.00	0.02	0.00
Hairy Woodpecker (<i>Picoides villosus</i>)	0.41	0.21	0.51	Rose-breasted Grosbeak (<i>Pheucticus ludovicianus</i>)	0.00	0.02	0.00
Willow Flycatcher (<i>Empidonax traillii</i>)	0.00	0.00	0.05	Lazuli Bunting (<i>Passerina amoena</i>)	0.23	0.19	0.23
Dusky Flycatcher (<i>Empidonax oberholseri</i>)	0.02	0.07	0.19	Indigo Bunting (<i>Passerina cyanea</i>)	1.49	0.67	0.81
Cordilleran Flycatcher (<i>Empidonax occidentalis</i>)	0.02	0.07	0.00	Red-winged Blackbird (<i>Agelaius phoeniceus</i>)	1.35	1.74	3.70
Black Phoebe (<i>Sayornis nigricans</i>)	0.12	0.05	0.25	Eastern Meadowlark (<i>Sturnella magna</i>)	0.00	0.00	0.02
Western Kingbird (<i>Tyrannus verticalis</i>)	0.05	0.09	0.32	Western Meadowlark (<i>Sturnella neglecta</i>)	2.36	1.41	1.69
Plumbeous Vireo (<i>Vireo plumbeus</i>)	0.12	0.19	0.23	Brewer's Blackbird (<i>Euphagus cyanocephalus</i>)	0.00	0.02	0.00
Cassin's Vireo (<i>Vireo cassinii</i>)	0.00	0.02	0.00	Common Grackle (<i>Quiscalus quiscula</i>)	0.02	0.00	0.05
Warbling Vireo (<i>Vireo gilvus</i>)	0.02	0.35	0.79	Great-tailed Grackle (<i>Quiscalus mexicanus</i>)	0.07	0.02	0.02
Western Scrub-Jay (<i>Aphelocoma californica</i>)	0.02	0.00	0.05	Bullock's Oriole (<i>Icterus galbula</i>)	0.43	0.46	0.83
Pinon Jay (<i>Gymnorhinus cyanocephalus</i>)	0.00	0.00	0.35	House Finch (<i>Carpodacus mexicanus</i>)	0.64	0.51	1.74
Black-billed Magpie (<i>Pica pica</i>)	0.09	0.09	0.12	Pine Siskin (<i>Carduelis pinus</i>)	0.02	0.42	0.09
American Crow (<i>Corvus brachyrhynchos</i>)	2.22	2.48	4.03	Lesser Goldfinch (<i>Carduelis psaltria</i>)	1.85	1.23	2.20
Chihuahuan Raven (<i>Corvus cryptoleucus</i>)	0.07	0.00	0.07	American Goldfinch (<i>Carduelis tristis</i>)	0.02	0.02	0.07
Common Raven (<i>Corvus corax</i>)	1.47	0.32	0.86	Evening Grosbeak (<i>Coccothraustes vespertinus</i>)	0.00	0.12	0.00
				House Sparrow (<i>Passer domesticus</i>)	0.02	0.02	0.25

Table 9. Most Common Species on Winter Surveys 2002 & 2003
(detections per 100 minutes of surveying)

2002 SPECIES	North	Middle	South	TOTAL
American Crow (<i>Corvus brachyrhynchos</i>)	77.42	42.19	26.72	48.53
Northern Flicker (<i>Colaptes auratus</i>)	2.82	5.08	3.88	3.89
House Finch (<i>Carpodacus mexicanus</i>)	5.24	2.34	1.29	2.95
White-breasted Nuthatch (<i>Sitta carolinensis</i>)	4.03	2.34	1.29	2.55
Spotted Towhee (<i>Pipilo maculatus</i>)	3.23	3.13	0.43	2.28
Black-capped Chickadee (<i>Poecile atricapilla</i>)	4.03	2.34	0.00	2.14
Bewick's Wren (<i>Thryomanes bewickii</i>)	2.82	0.00	0.86	1.21
American Goldfinch (<i>Carduelis tristis</i>)	0.81	1.56	0.86	1.07
Bald Eagle (<i>Haliaeetus leucocephalus</i>)	1.61	1.17	0.00	0.94
Downy Woodpecker (<i>Picoides pubescens</i>)	1.21	1.17	0.43	0.94
Common Raven (<i>Corvus corax</i>)	0.00	1.17	1.72	0.94
Brown Creeper (<i>Certhia americana</i>)	1.21	1.56	0.00	0.94
2003 SPECIES	North	Middle	South	TOTAL
American Crow (<i>Corvus brachyrhynchos</i>)	205.24	88.67	18.10	104.29
American Robin (<i>Turdus migratorius</i>)	62.50	47.27	20.26	43.30
House Finch (<i>Carpodacus mexicanus</i>)	6.05	7.42	10.78	7.91
European Starling (<i>Sturnus vulgaris</i>)	4.03	15.23	0.00	6.57
Cedar Waxwing (<i>Bombycilla cedrorum</i>)	0.00	18.36	0.00	6.30
White-breasted Nuthatch (<i>Sitta carolinensis</i>)	6.45	7.81	1.72	5.36
Spotted Towhee (<i>Pipilo maculatus</i>)	7.66	5.86	2.59	5.36
Northern Flicker (<i>Colaptes auratus</i>)	4.03	5.08	4.31	4.42
Yellow-rumped Warbler (<i>Dendroica coronata</i>)	0.40	10.55	0.00	3.75
Black-capped Chickadee (<i>Poecile atricapilla</i>)	3.63	5.08	0.00	2.95
Steller's Jay (<i>Cyanocitta stelleri</i>)	4.03	3.52	0.43	2.68
Bewick's Wren (<i>Thryomanes bewickii</i>)	2.02	1.56	4.31	2.55

Table 10. Nesting Success Rates of Common Species in Native and Exotic Plants 2000-2002

Species	Native Plants					Exotic Plants				
	Success	Failed	Unknown	Total	% Success	Success	Failed	Unknown	Total	% Success
Cup Nesters										
Black-chinned Hummingbird	29	20	24	73	59.18	99	48	33	180	67.35
Phainopepla	6	6	9	21	50.00	4	2		6	66.67
Summer Tanager	3	4	5	12	42.86				0	
Black-headed Grosbeak	1	1	7	9	50.00	6	3	5	14	66.67
Blue Grosbeak	1			1	100.00	3	7	6	16	30.00
Totals	40	31	45	116	56.34	112	60	44	216	65.12
	Native Plants					Exotic Plants				
	Success	Failed	Unknown	Total	% Success	Success	Failed	Unknown	Total	% Success
Cavity Nesters										
American Kestrel	2		1	3	100.00				0	
Downy Woodpecker	18		10	28	100.00				0	
Northern Flicker		1	9	10	0.00				0	
Ash-throated Flycatcher	10		18	28	100.00				0	
Bewick's Wren	10	1	10	21	90.91	2			2	100.00
Totals	40	2	48	90	95.24	2	0	0	2	100.00
	Native Plants					Exotic Plants				
	Success	Failed	Unknown	Total	% Success	Success	Failed	Unknown	Total	% Success
Stick Nesters										
Cooper's Hawk	20		2	22	100.00				0	
Swainson's Hawk	6		1	7	100.00				0	
Mourning Dove	3	13	3	19	18.75	6	20	11	37	23.08
Totals	29	13	6	48	69.05	6	20	11	37	23.08

Table 11. Nesting Success Rates of Common Species in Understory (<10m) and Overstory (>10m) Plants 2000-20

Species	Understory					Overstory				
Cup Nesters	Success	Failed	Unknown	Total	% Success	Success	Failed	Unknown	Total	% Success
Black-chinned Hummingbird	116	62	45	223	65.17	9	4	6	19	69.23
Phainopepla	6	7	7	20	46.15	4	1	2	7	80.00
Summer Tanager	1	3	2	6	25.00	2	1	2	5	66.67
Black-headed Grosbeak	7	4	11	22	63.64			1	1	
Blue Grosbeak	4	7	6	17	36.36				0	
Totals	134	83	71	288	61.75	15	6	11	32	71.43
	Understory					Overstory				
Cavity Nesters	Success	Failed	Unknown	Total	% Success	Success	Failed	Unknown	Total	% Success
American Kestrel	2		1	3	100.00				0	
Downy Woodpecker	10		8	18	100.00	8		1	9	100.00
Northern Flicker		1	5	6	0.00			3	3	
Ash-throated Flycatcher	8		11	19	100.00	2		4	6	100.00
Bewick's Wren	9	1	8	18	90.00	2		1	3	100.00
Totals	29	2	33	64	93.55	12	0	9	21	100.00
	Understory					Overstory				
Stick Nesters	Success	Failed	Unknown	Total	% Success	Success	Failed	Unknown	Total	% Success
Cooper's Hawk	3			3	100.00	17		2	19	100.00
Swainson's Hawk				0		6		1	7	100.00
Mourning Dove	8	33	14	55	19.51				0	
Totals	11	33	14	58	25.00	23	0	3	26	100.00

Table 12. Nests Located on Fire Effects Sites 2001-2002

Species	2001					2002									
	S	F	U	TOTAL	%S	S	F	U	TOTAL	%S	S	F	U	TOTAL	%S
Cooper's Hawk	0	0	0	0		1	0	0	1	100.00	1	0	0	1	100.00
American Kestrel	0	0	0	0		2	0	0	2	100.00	2	0	0	2	100.00
Mourning Dove	0	1	0	1	0.00	5	11	4	20	31.25	5	11	4	21	31.25
Great Horned Owl	0	0	0	0		1	0	0	1	100.00	1	0	0	1	100.00
Black-chinned Hummingbird	0	0	0	0		6	2	2	10	75.00	6	2	2	10	75.00
Downy Woodpecker	0	0	0	0		1	0	0	1	100.00	1	0	0	1	100.00
Hairy Woodpecker	0	0	0	0		1	0	0	1	100.00	1	0	0	1	100.00
Northern Flicker	0	0	1	1		1	0	1	2	100.00	1	0	2	3	100.00
Western Wood-Pewee	0	1	0	1	0.00	0	1	0	1	0.00	0	2	0	2	0.00
Ash-throated Flycatcher	1	0	0	1	100.00	1	0	1	2	100.00	2	0	1	3	100.00
Western Kingbird	0	0	1	1		2	5	3	10	28.57	2	5	4	11	28.57
Bewick's Wren	0	0	0	0		1	0	1	2	100.00	1	0	1	2	100.00
White-breasted Nuthatch	0	0	2	2		0	0	0	0		0	0	2	2	
Gray Catbird	0	0	0	0		0	0	1	1		0	0	1	1	
Northern Mockingbird	0	0	0	0		1	0	0	1	100.00	1	0	0	1	100.00
Summer Tanager	0	0	0	0		3	0	0	3	100.00	3	0	0	3	100.00
Spotted Towhee	0	0	0	0		0	1	0	1	0.00	0	1	0	1	0.00
Black-headed Grosbeak	0	0	1	1		1	1	1	3	50.00	1	1	2	4	50.00
Lazuli Bunting	0	0	0	0		0	1	0	1	0.00	0	1	0	1	0.00
Bullock's Oriole	0	0	0	0		2	0	0	2	100.00	2	0	0	2	100.00
Lesser Goldfinch	0	0	1	1		0	0	0	0		0	0	1	1	
TOTALS	1	2	6	9	33.33	29	22	14	65	56.86	30	23	20	74	56.60

Table 13. Ecological Characteristics Percentages

Sites	C/ Yerba mansa 1.	C/ Forestiera pubescens	C/ Salix gooddingii 1.	C/ Salix exigua 1.	C/ Elaeagnus angustifolia	C/ ELAN- TARA	C/ Tamarix ramosissima	2.
North 1			25.00	12.50	25.00	37.50		
North 2					25.00	75.00		
North 3						100.00		
North 4						100.00		
North ave.	0.000	0.000	6.250	3.125	12.500	78.125	0.000	
Middle 1				37.50		25.00	37.50	
Middle 2	12.50			12.50		75.00		
Middle 7				12.50	62.50	25.00		
Middle 3	50.00					37.50	12.50	
Middle 4		12.50	50.00			25.00	12.50	
Middle ave.	12.500	2.500	10.000	12.500	12.500	37.500	12.500	
South 1			25.00			37.50	37.50	
South 2		100.00						
South 3		12.50	25.00				62.50	
South 4		12.50					87.50	
South ave.	0.000	31.250	12.500	0.000	0.000	9.375	46.875	

C= Populus deltoides

2. In order of dicotomous key.

1. Mesic types

See appendix for definition and citation.

Table14. Cover Percentages by Hink and Ohmart Cover Classes

Sites	Classes						Average Fire frequency
	I	II	III	IV	V	VI	
North 1	100.000						30.00
North 2	100.000						30.00
North 3	100.000						24.44
North 4	93.750					6.250	35.63
North ave.	98.438	0.000	0.000	0.000	0.000	1.563	30.02
Middle 1	31.250		43.750	12.500	12.500		16.22
Middle 2	18.750	56.250	25.000				40.00
Middle 7	62.500			25.000	12.500		40.00
Middle 3	100.000						25.63
Middle 4	75.000		18.750			6.250	10.46
Middle ave.	57.500	11.250	17.500	7.500	5.000	1.250	26.46
South 1	37.500		25.000		31.250	6.250	26.25
South 2	75.000			25.000			13.00
South 3	25.000		43.750		12.500	18.750	15.88
South 4	62.500		18.750	12.500	6.250		18.75
South ave.	50.000	0.000	21.875	9.375	12.500	6.250	18.47

See appendix for definition and citation.

Table15. Variation in Percent Canopy Closure						
BLOCK	SITE NAME	Median CANOPY CLOSURE	Variation	Standard Deviation	Minimum CANOPY CLOSURE	Maximum CANOPY CLOSURE
NORTH	NORTH 1	96.35	4.11	85.42	100.00	
	NORTH 2	96.87	2.25	93.23	100.00	
	NORTH 3	96.35	4.84	83.33	100.00	
	NORTH 4	94.01	5.51	84.37	100.00	
MIDDLE	MIDDLE 1	96.61	17.70	39.06	100.00	
	MIDDLE 2	92.97	15.24	55.21	97.92	
	MIDDLE 3	95.05	5.23	83.33	100.00	
	MIDDLE 4	93.49	4.69	83.85	100.00	
	MIDDLE 7	73.97	28.32	23.96	99.77	
SOUTH	SOUTH 1	96.09	32.57	0.00	100.00	
	SOUTH 2	79.17	26.00	21.35	96.87	
	SOUTH 3	75.52	29.94	0.52	100.00	
	SOUTH 4	76.04	28.14	0.00	100.00	

Table16. Overstory Vegetation Layer (> 10.1 Meters high)

BLOCK	SITE NAME	SPECIES NAME 1.	Ave DBH cm	Ave Height m	AveTrees/HA	BA/HA m2	Site Basal Ar m2/H
NORTH	NORTH 1	Populus deltoides	51.0	19.9	177	36.1	38.9
	NORTH 1	Salix gooddingii	25.0	10.2	50	2.4	
	NORTH 1	Ulmus pumila	26.4	13.5	11	0.3	
	NORTH 1	Acer negundo	30.3	15.7	4	0.1	
	NORTH 2	Populus deltoides	50.5	18.3	152	30.4	31.4
	NORTH 2	Ulmus pumila	24.3	13.2	32	0.9	
	NORTH 2	Gleditsia triacanthos	9.0	12.0	12	0.1	
	NORTH 3	Populus deltoides	37.9	19.8	286	32.2	33.3
	NORTH 3	Salix gooddingii	13.3	10.3	77	1.1	
	NORTH 4	Populus deltoides	56.1	19.4	97	23.9	25.1
	NORTH 4	Ulmus pumila	41.0	14.5	7	1.2	
MIDDLE	MIDDLE 1	Populus deltoides	32.0	19.2	392	31.5	35.0
	MIDDLE 1	Salix gooddingii	29.1	11.0	36	2.4	
	MIDDLE 1	Morus alba	12.3	13.1	234	1.1	
	MIDDLE 2	Populus deltoides	36.7	15.3	298	31.4	31.6
	MIDDLE 2	Salix gooddingii	15.5	10.2	13	0.2	
	MIDDLE 3	Populus deltoides	45.7	18.4	183	29.8	29.8
	MIDDLE 4	Populus deltoides	36.0	15.6	482	49.0	53.0
	MIDDLE 4	Salix gooddingii	21.7	11.9	109	4.0	
	MIDDLE 7	Populus deltoides	42.1	18.0	194	26.8	26.8
SOUTH	SOUTH 1	Populus deltoides	29.2	14.4	450	30.2	30.2
	SOUTH 2	Populus deltoides	53.8	15.7	86	19.5	19.5
	SOUTH 3	Populus deltoides	24.6	13.3	883	42.1	42.1
	SOUTH 4	Populus deltoides	31.2	12.5	310	23.7	23.7
			Table 4b.	Overstory Variation by Block			
			Block	Average Basal Area m2/HA		Standard Deviation	
	1. see Appendix 1.		NORTH	32.18		5.69	
			MIDDLE	35.24		10.36	
			SOUTH	28.88		9.85	

Table 17 Understory Vegetation Layer (0.5-10 meters high)

SITE NAME	SPECIES NAME	1.	Ave DBH cm	Ave Height m	Ave Plants/HA	BA/HA m2	Site Basal Area
NORTH 1	Tamarix ramosissima		7.62	6.23	1109	6.41	10.72
	Elaeagnus angustifolia		9.29	5.81	610	3.54	
	Parthenocissus quinquefolia		1.00	4.00	548		
	Ribes aureum		1.00	2.00	527		
	Morus alba		10.48	8.68	133	0.77	
	Salix exigua		1.00	2.00	32		
	Ulmus pumila		1.00	2.00	61		
NORTH 2	Elaeagnus angustifolia		10.82	7.87	846	5.67	13.32
	Tamarix ramosissima		9.73	7.70	689	4.25	
	Ailanthus altissima		1.73	3.00	161	3.40	
	Amorpha fruticosa		1.00	2.50	64		
	Ulmus pumila		1.00	2.00	24		
	Lycium pallidum		1.00	2.00	22		
NORTH 3	Tamarix ramosissima		6.00	7.38	3492	12.89	17.90
	Elaeagnus angustifolia		12.41	9.10	645	5.01	
	Parthenocissus quinquefolia		1.00	3.00	556		
	Salix exigua		1.00	2.00	34		
	Amorpha fruticosa		1.00	2.00	23		
NORTH 4	Tamarix ramosissima		8.46	9.30	1602	9.16	11.30
	Parthenocissus quinquefolia		1.00	3.00	548		
	Elaeagnus angustifolia		10.91	7.35	232	2.14	
	Ribes aureum		1.00	1.50	105		
	Salix exigua		1.00	2.00	64		
	Ulmus pumila		1.20	3.00	34		
	Atriplex canescens		1.00	1.00	32		
MIDDLE 1	Salix exigua		1.00	2.10	1768		2.80
	Tamarix ramosissima		2.66	4.98	1760	1.98	
	Morus alba		1.00	2.50	731		
	Elaeagnus angustifolia		11.96	6.91	723	0.82	
	Baccharis salicina		1.00	3.00	442		
	Ribes aureum		1.00	2.00	63		
	Amorpha fruticosa		1.00	2.00	42		
MIDDLE 2	Tamarix ramosissima		1.86	7.35	2078	0.94	1.47
	Salix exigua		1.00	2.00	1958		
	Baccharis salicina		1.00	2.00	484		
	Amorpha fruticosa		1.00	2.00	147		
	Elaeagnus angustifolia		9.30	7.27	105	0.53	
	Parthenocissus quinquefolia		2.00	4.00	22		
MIDDLE 3	Tamarix ramosissima		3.66	7.02	3126	4.54	8.33
	Elaeagnus angustifolia		5.70	5.03	919	2.55	
	Salix gooddingii		26.95	7.30	22	1.24	
MIDDLE 4	Tamarix ramosissima		5.87	6.48	3147	10.53	10.53
	Forestiera pubescens		1.00	3.00	716		
MIDDLE 7	Salix exigua		1.00	2.50	2213		6.78
	Tamarix ramosissima		2.99	6.40	825	2.44	
	Elaeagnus angustifolia		12.31	6.68	400	3.10	
	Salix gooddingii		5.00	5.85	125	0.24	

SITE NAME	SPECIES NAME 1.	Ave DBH cm	Ave Height m	Ave Plants/HA	BA/HA m2	Site Basal Area
SOUTH 1	Tamarix ramosissima	2.58	4.95	3483	2.82	2.82
	Amorpha fruticosa	1.00	2.00	127		
	Forestiera pubescens	1.00	2.50	22		
	Baccharis salicina	1.00	2.00	11		
	Lycium pallidum	1.00	1.50	11		
SOUTH 2	Forestiera pubescens	1.00	2.50	2216		
	Tamarix ramosissima	9.07	5.98	1293	8.35	8.35
	Baccharis salicifolia	1.00	2.00	108		
	Lycium pallidum	1.00	1.50	31		
SOUTH 3	Tamarix ramosissima	3.20	8.10	4865	6.10	8.10
	Forestiera pubescens	1.00	2.50	1200		
	Baccharis salicifolia	1.00	2.00	243		
	Salix gooddingii	12.75	7.75	157	2.00	
	Lycium pallidum	1.00	1.50	85		
	Amorpha fruticosa	1.00	2.00	22		
SOUTH 4	Tamarix ramosissima	2.24	5.00	3491	1.89	2.13
	Baccharis salicifolia	1.00	2.00	885		
	Amorpha fruticosa	1.00	2.00	295		
	Lycium pallidum	1.00	1.50	95		
	Forestiera pubescens	1.00	2.50	85		
	Prosopis pubescens	11.20	6.30	25	0.24	

Table 17b. Understory Variation by Block

Block	Kind	Range in Basal Area m2/HA		Standard Deviation
		Minimum	Maximum	
North	Exotic	10.72	17.90	3.26
	Native	0.00	0.00	
Middle	Exotic	1.47	10.53	3.61
	Native	0.00	1.24	0.54
South	Exotic	1.89	8.35	2.98
	Native	0.00	2.00	0.97

1. See Appendix 5

Table 18.

Percentage of Ground Cover Classes

SITE NAME	BARE %	FORB %	GRASS %	LITTER %	DEAD-DOWN %	SHRUB %	TREE %	OTHER %
NORTH 1	1.09	0.36	0.36	85.64	10.00	0.18	0.36	2.00
NORTH 2	4.36	0.00	0.00	89.09	6.00	0.00	0.55	0.00
NORTH 3	0.73	0.18	0.18	86.18	10.00	0.18	1.64	0.91
NORTH 4	2.00	0.55	0.18	78.18	18.18	0.00	0.91	0.00
average	2.05	0.27	0.18	84.77	11.05			
Standard Deviation	1.64	0.23	0.15	4.65	5.12			
MIDDLE 1	7.09	1.45	0.73	82.18	6.18	1.45	0.73	0.18
MIDDLE 2	6.00	0.91	8.91	77.45	4.91	0.36	1.45	0.00
MIDDLE 3	4.18	17.09	0.73	68.73	7.09	0.00	2.18	0.00
MIDDLE 4	2.73	0.18	0.55	90.91	4.00	0.00	1.27	0.36
MIDDLE 7	4.00	4.18	9.45	67.82	11.09	0.18	3.27	0.00
average	4.80	4.76	4.07	77.42	6.65			
Standard Deviation	1.73	7.06	4.67	9.65	2.75			
SOUTH 1	27.82	0.55	1.27	62.00	3.09	0.00	0.73	4.55
SOUTH 2	12.50	0.00	0.50	77.50	8.50	0.50	0.25	0.00
SOUTH 3	7.27	0.18	0.18	83.09	8.18	0.00	1.09	0.00
SOUTH 4	5.64	0.18	3.27	80.91	8.55	0.36	1.09	0.00
average	13.31	0.23	1.31	75.88	7.08			
Standard Deviation	10.11	0.23	1.39	9.53	2.66			

**Relative abundance of plants in the
Ground Vegetation Layer**

Table 19.

SITE NAME	SPECIES NAME 1.	CLASS	KIND	RELATIVE STEM COUNT
NORTH 1	Acroptilon repens	FORB	EXOTIC	250
	Anemopsis californica	FORB	NATIVE	50
NORTH 2	Chloracantha spinosa	FORB	NATIVE	50
	Solanum elaeagnifolium	FORB	NATIVE	50
	Panicum capillare	GRASS	NATIVE	100
	Elymus elymoides	GRASS	NATIVE	52
NORTH 4	Descurainia sophia	FORB	EXOTIC	350
	Solanum elaeagnifolium	FORB	NATIVE	150
	Lactuca serriola	FORB	NATIVE	102
	Acroptilon repens	FORB	EXOTIC	50
	Kochia scoparia	FORB	EXOTIC	50
	Salsola kali	FORB	EXOTIC	25
	Verbesina encelioides	FORB	NATIVE	25
MIDDLE 1	Ambrosia psilostachya	FORB	NATIVE	795
	Ratibida tagetes	FORB	NATIVE	202
	Grindelia Nuda	FORB	NATIVE	130
	Melilotus albus	FORB	NATIVE	110
	Lactuca serriola	FORB	NATIVE	72
	Physalis virginiana	FORB	NATIVE	50
	Asclepias tuberosa	FORB	NATIVE	10
	Glycyrrhiza lepidota	FORB	NATIVE	10
	Panicum virgatum	GRASS	NATIVE	100
	Carex praegracilis	SEDGE	NATIVE	200
	Schoenoplectus americanus	SEDGE	NATIVE	200
MIDDLE 2	Sphaerophysa salsula	FORB	NATIVE	552
	Melilotus albus	FORB	NATIVE	406
	Ambrosia psilostachya	FORB	NATIVE	375
	Ratibida tagetes	FORB	NATIVE	250
	Kochia scoparia	FORB	EXOTIC	154
	Helianthus annuus	FORB	NATIVE	106
	Clematis drummondii	FORB	NATIVE	100
	Conyza canadensis	FORB	NATIVE	100
	Chloracantha spinosa	FORB	NATIVE	52
	Asclepias tuberosa	FORB	NATIVE	50
	Solidago simplex	FORB	NATIVE	25
	Asclepias subverticillata	FORB	NATIVE	20
	Panicum capillare	GRASS	NATIVE	626
	Panicum virgatum	GRASS	NATIVE	382
	Elymus elymoides	GRASS	NATIVE	150
	Sporobolus cryptandrus	GRASS	NATIVE	20

SITE NAME	SPECIES NAME 1.	CLASS	KIND	RELATIVE STEM COUNT
MIDDLE 3	Anemopsis californica	FORB	NATIVE	1832
	Panicum capillare	GRASS	NATIVE	705
MIDDLE 4	Sporobolus cryptandrus	GRASS	NATIVE	60
	Panicum virgatum	GRASS	NATIVE	30
	Juncus mexicanus	RUSH	NATIVE	30
	Descurainia sophia	FORB	EXOTIC	402
	Lactuca serriola	FORB	NATIVE	108
	Equisetum laevigatum	FORB	NATIVE	100
	Sphaerophysa salsula	FORB	NATIVE	100
	Clematis drummondii	FORB	NATIVE	75
	Conyza canadensis	FORB	NATIVE	50
	Solanum elaeagnifolium	FORB	NATIVE	50
	Agrostis gigantea	GRASS	EXOTIC	200
	Sporobolus cryptandrus	GRASS	NATIVE	120
	Panicum capillare	GRASS	NATIVE	15
	Ratibida tagetes	FORB	NATIVE	150
MIDDLE 7	Anemopsis californica	FORB	NATIVE	100
	Melilotus albus	FORB	NATIVE	100
	Ambrosia psilostachya	FORB	NATIVE	78
	Asclepias tuberosa	FORB	NATIVE	60
	Chloracantha spinosa	FORB	NATIVE	60
	Asclepias subverticillata	FORB	NATIVE	50
	Sporobolus cryptandrus	GRASS	NATIVE	1286
	Panicum virgatum	GRASS	NATIVE	550
	Panicum capillare	GRASS	NATIVE	100
	Sporobolus airoides	GRASS	NATIVE	40
SOUTH 1	Solanum elaeagnifolium	FORB	NATIVE	300
	Sphaerophysa salsula	FORB	NATIVE	270
	Conyza canadensis	FORB	NATIVE	204
	Descurainia sophia	FORB	EXOTIC	200
	Senecio flaccidus	FORB	NATIVE	145
	Ipomopsis longiflora	FORB	NATIVE	102
	Chloracantha spinosa	FORB	NATIVE	100
	Melilotus albus	FORB	NATIVE	76
	Sonchus asper	FORB	EXOTIC	75
	Physalis virginiana	FORB	NATIVE	50
	Chamaesyce serpens	FORB	NATIVE	11
	Portulaca oleracea	FORB	NATIVE	10
	Panicum capillare	GRASS	NATIVE	225
	Aristida purpurea	GRASS	NATIVE	77
	Sporobolus contractus	GRASS	NATIVE	22
SOUTH 2	Solanum elaeagnifolium	FORB	NATIVE	202
	Ratibida tagetes	FORB	NATIVE	150
	Helianthus ciliaris	FORB	NATIVE	100
	Conyza canadensis	FORB	NATIVE	50
	Descurainia sophia	FORB	EXOTIC	50
	Verbesina encelioides	FORB	NATIVE	26
	Sporobolus contractus	GRASS	NATIVE	104
	Lycurus phleoides	GRASS	EXOTIC	50
	Agrostis gigantea	GRASS	EXOTIC	25

SITE NAME	SPECIES NAME	1.	CLASS	KIND	RELATIVE STEM COUNT
SOUTH 3	Ratibida tagetes		FORB	NATIVE	354
	Conyza canadensis		FORB	NATIVE	200
	Solanum elaeagnifolium		FORB	NATIVE	100
	Ambrosia psilostachya		FORB	NATIVE	78
	Chloracantha spinosa		FORB	NATIVE	52
	Descurainia sophia		FORB	EXOTIC	50
	Melilotus albus		FORB	NATIVE	50
	Chamaesyce serpens		FORB	NATIVE	25
SOUTH 4	Sphaerophysa salsula		FORB	NATIVE	300
	Anemopsis californica		FORB	NATIVE	200
	Kochia scoparia		FORB	EXOTIC	100
	Descurainia sophia		FORB	EXOTIC	50
	Asclepias subverticillata		FORB	NATIVE	20
	Panicum capillare		GRASS	NATIVE	475
	Sporobolus cryptandrus		GRASS	NATIVE	306
	Agrostis gigantea		GRASS	EXOTIC	300
	Sporobolus contractus		GRASS	NATIVE	50
	Juncus mexicanus		RUSH	NATIVE	150
	Typha angustifolia		RUSH	NATIVE	125
	Scirpus acutus		RUSH	NATIVE	26
	Schoenoplectus americanus		SEDGE	NATIVE	200

1. see Appendix 5.

Table 20.

Existing Snags

SITE NAME	SPECIES NAME	1.	KIND	LIVE/DEAD	AveDBH cm	AveTrees/HA	BA/HA m2
NORTH 1	Populus deltoides		NATIVE	DEAD	41.00	26.34	3.48
NORTH 2	Populus deltoides		NATIVE	DEAD	42.52	10.51	1.49
NORTH 2	Elaeagnus angustifolia		EXOTIC	DEAD	12.12	72.73	0.84
NORTH 3	Populus deltoides		NATIVE	DEAD	27.41	57.11	3.37
NORTH 4	Populus deltoides		NATIVE	DEAD	69.01	2.41	0.90
MIDDLE 1	Populus deltoides		NATIVE	DEAD	28.07	11.38	0.70
MIDDLE 1	Salix gooddingii		NATIVE	DEAD	14.00	15.88	0.24
MIDDLE 2						0.00	0.00
MIDDLE 3	Populus deltoides		NATIVE	DEAD	35.66	33.55	3.35
MIDDLE 3	Tamarix ramosissima		EXOTIC	DEAD	8.00	48.63	0.24
MIDDLE 4						0.00	0.00
MIDDLE 7	Elaeagnus angustifolia		EXOTIC	DEAD	22.00	6.43	0.24
MIDDLE 7	Populus deltoides		NATIVE	DEAD	41.00	1.85	0.24
SOUTH 1	Populus deltoides		NATIVE	DEAD	18.34	71.46	1.89
SOUTH 2	Populus deltoides		NATIVE	DEAD	53.04	15.35	3.39
SOUTH 3	Populus deltoides		NATIVE	DEAD	41.15	36.88	4.91
SOUTH 3	Salix gooddingii		NATIVE	DEAD	15.49	91.44	1.72
SOUTH 4	Populus deltoides		NATIVE	DEAD	33.76	45.41	4.06
SITE SUMMARY				Snags/HA	Basal Area/HA m2		
NORTH 1				26.34	3.48		
NORTH 2				83.24	2.33		
NORTH 3				57.11	3.37		
NORTH 4				2.41	0.90		
Average				42.28	2.52		
Standard Deviation				35.31	1.20		
MIDDLE 1				54.88	0.95		
MIDDLE 2				0.00	0.00		
MIDDLE 3				82.18	3.60		
MIDDLE 4				0.00	0.00		
MIDDLE 7				8.28	0.49		
Average				29.07	1.01		
Standard Deviation				37.45	1.50		
SOUTH 1				71.46	1.89		
SOUTH 2				15.35	3.39		
SOUTH 3				128.32	6.63		
SOUTH 4				45.41	4.06		
Average				65.13	3.99		
Standard Deviation				47.96	1.98		

1. see Appendix 5.

Table 21.

Large Down Logs (> 20 cm)

SITE NAME	Logs/HA
NORTH 1	21.80
NORTH 2	12.70
NORTH 3	29.10
NORTH 4	43.60
average	26.80
Standard Deviation	13.06
MIDDLE 1	1.80
MIDDLE 2	3.10
MIDDLE 3	9.10
MIDDLE 4	12.70
MIDDLE 7	14.50
average	8.24
Standard Deviation	5.65
SOUTH 1	1.80
SOUTH 2	35.00
SOUTH 3	9.10
SOUTH 4	20.00
average	16.48
Standard Deviation	14.44

Table 22.

Small Dead and Down (2-20 cm)

SITE NAME	2-5 cm pieces/HA	5-20 cm pieces/HA
NORTH 1	2036.00	782.00
NORTH 2	1956.00	436.00
NORTH 3	2440.00	644.00
NORTH 4	1811.00	1062.00
average	2060.75	731.00
Standard Deviation	269.44	262.52
MIDDLE 1	1575.00	215.00
MIDDLE 2	646.00	142.00
MIDDLE 3	1575.00	607.00
MIDDLE 4	1160.00	385.00
MIDDLE 7	1218.00	440.00
average	1234.80	357.80
Standard Deviation	382.11	184.77
SOUTH 1	993.00	185.00
SOUTH 2	1390.00	215.00
SOUTH 3	2247.00	636.00
SOUTH 4	1233.00	458.00
average	1465.75	373.50
Standard Deviation	545.82	213.46

Table 23.

Treatment Fuel Loads

SITE	DEAD DOWN < 3" TONS/AC	DEAD DOWN > 3" TONS/AC	LIVE EXOTIC TONS/AC	TOTAL TREATMENT FUEL LOAD TONS/AC
NORTH 1	13.55	6.75	18.64	38.94
NORTH 2	9.41	5.98	31.13	46.52
NORTH 3	11.61	4.70	34.28	50.59
NORTH 4	7.32	9.39	16.83	33.54
average	10.47	6.71	25.22	42.40
Standard Deviation	2.70	1.98	8.77	7.63
MIDDLE 1	8.00	0.89	21.53	30.42
MIDDLE 2	3.23	0.92	17.08	21.23
MIDDLE 3	7.63	9.45	24.38	41.46
MIDDLE 7	4.07	3.86	13.12	21.05
average	5.73	3.78	19.03	28.54
Standard Deviation	2.43	4.03	4.95	9.66
SOUTH 1	3.87	0.88	23.50	28.25
SOUTH 2	5.20	7.33	3.05	15.58
SOUTH 3	13.02	5.20	30.77	48.99
SOUTH 4	8.03	4.46	25.19	37.68
average	7.53	4.47	20.63	32.63
Standard Deviation	4.05	2.68	12.12	14.18

Table 24. Species Detected at BNWR Fire Effects Sites on Breeding Season Surveys 2001-2002
(detections per 100 survey minutes)

SPECIES	2001	2002	SPECIES	2001	2002
Neotropic Cormorant (<i>Phalacrocorax olivaceus</i>)	0.00	0.99	Chihuahuan Raven (<i>Corvus cryptoleucus</i>)	0.00	0.20
Great Blue Heron (<i>Ardea herodias</i>)	0.58	0.00	Common Raven (<i>Corvus corax</i>)	0.58	0.00
Black-crowned Night-Heron (<i>Nycticorax nycticorax</i>)	0.29	0.99	Cliff Swallow (<i>Hirundo pyrrhonota</i>)	0.00	0.40
White-faced Ibis (<i>Plegadis chihi</i>)	0.00	0.20	Barn Swallow (<i>Hirundo rustica</i>)	0.87	0.40
Turkey Vulture (<i>Cathartes aura</i>)	0.29	0.00	Bushtit (<i>Psaltirparus minimus</i>)	0.00	0.79
Canada Goose (<i>Branta canadensis</i>)	0.58	1.59	Bewick's Wren (<i>Thryomanes bewickii</i>)	13.01	15.08
Wood Duck (<i>Aix sponsa</i>)	0.00	0.20	House Wren (<i>Troglodytes aedon</i>)	0.00	0.20
Gadwall (<i>Anas strepera</i>)	0.00	0.99	Blue-gray Gnatcatcher (<i>Polioptila caerulea</i>)	0.00	0.40
Mallard (<i>Anas platyrhynchos</i>)	0.00	4.76	American Robin (<i>Turdus migratorius</i>)	0.00	0.40
Green-winged Teal (<i>Anas crecca</i>)	0.58	0.00	Gray Catbird (<i>Dumetella carolinensis</i>)	0.00	0.79
Swainson's Hawk (<i>Buteo swainsoni</i>)	0.29	0.00	Northern Mockingbird (<i>Mimus polyglottos</i>)	0.00	1.39
Red-tailed Hawk (<i>Buteo jamaicensis</i>)	0.00	0.20	Phainopepla (<i>Phainopepla nitens</i>)	0.00	0.20
American Kestrel (<i>Falco sparverius</i>)	2.89	1.59	Lucy's Warbler (<i>Vermivora luciae</i>)	0.00	1.19
Ring-necked Pheasant (<i>Phasianus colchicus</i>)	0.58	7.54	Yellow-rumped Warbler (<i>Dendroica coronata</i>)	0.00	0.60
Wild Turkey (<i>Meleagris gallopavo</i>)	0.29	0.00	MacGillivray's Warbler (<i>Oporornis tolmiei</i>)	0.00	0.79
Gambel's Quail (<i>Callipepla gambelii</i>)	1.16	1.98	Common Yellowthroat (<i>Geothlypis trichas</i>)	1.73	3.57
Killdeer (<i>Charadrius vociferus</i>)	0.29	3.77	Wilson's Warbler (<i>Wilsonia pusilla</i>)	0.00	1.19
Black-necked Stilt (<i>Himantopus mexicanus</i>)	0.00	0.40	Yellow-breasted Chat (<i>Icteria virens</i>)	16.18	17.66
Spotted Sandpiper (<i>Actitis macularia</i>)	0.87	1.59	Summer Tanager (<i>Piranga rubra</i>)	1.73	4.76
Mourning Dove (<i>Zenaida macroura</i>)	8.96	17.66	Western Tanager (<i>Piranga ludoviciana</i>)	0.00	0.60
Yellow-billed Cuckoo (<i>Coccyzus americanus</i>)	3.18	1.19	Chipping Sparrow (<i>Spizella passerina</i>)	0.00	0.60
Greater Roadrunner (<i>Geococcyx californianus</i>)	0.00	0.20	Lark Sparrow (<i>Chondestes grammacus</i>)	0.58	0.00
Black-chinned Hummingbird (<i>Archilochus alexandri</i>)	0.87	0.56	Spotted Towhee (<i>Pipilo maculatus</i>)	11.85	11.11
Broad-tailed Hummingbird (<i>Selasphorus platycercus</i>)	0.00	0.20	Black-headed Grosbeak (<i>Pheucticus melanocephalus</i>)	5.20	13.69
Ladder-backed Woodpecker (<i>Picoides scalaris</i>)	0.87	0.99	Blue Grosbeak (<i>Passerina caerulea</i>)	15.90	11.90
Downy Woodpecker (<i>Picoides pubescens</i>)	0.58	0.40	Lazuli Bunting (<i>Passerina amoena</i>)	0.00	0.20
Hairy Woodpecker (<i>Picoides villosus</i>)	0.58	0.99	Indigo Bunting (<i>Passerina cyanea</i>)	2.60	1.19
Northern Flicker (<i>Colaptes auratus</i>)	2.02	2.18	Red-winged Blackbird (<i>Agelaius phoeniceus</i>)	8.67	18.85
Western Wood-Pewee (<i>Contopus sordidulus</i>)	0.87	1.79	Western Meadowlark (<i>Sturnella neglecta</i>)	3.47	2.18
Dusky Flycatcher (<i>Empidonax oberholseri</i>)	0.00	0.79	Great-tailed Grackle (<i>Quiscalus mexicanus</i>)	0.29	0.00
Black Phoebe (<i>Sayornis nigricans</i>)	0.29	0.20	Brown-headed Cowbird (<i>Molothrus ater</i>)	9.83	27.38
Ash-throated Flycatcher (<i>Myiarchus cinerascens</i>)	6.65	10.12	Bullock's Oriole (<i>Icterus galbula</i>)	0.00	0.99
Western Kingbird (<i>Tyrannus verticalis</i>)	2.89	3.57	House Finch (<i>Carpodacus mexicanus</i>)	1.16	4.17
Warbling Vireo (<i>Vireo gilvus</i>)	0.00	0.20	Lesser Goldfinch (<i>Carduelis psaltria</i>)	2.31	2.38
American Crow (<i>Corvus brachyrhynchos</i>)	0.00	0.40			

Table 25. BNWR Fire Effects Sites Vegetation and Fuel Load

SITE	OVERSTORY/ UNDERSTORY	SPECIES NAME 1.	DEAD/ LIVE	Plants/HA 2.	DBH cm	BA/HA m2	Site Basal Area
SOUTH 5	OS	Podulus deltoides	DEAD	138	32.8	11.66	22.02
		Podulus deltoides	LIVE	118	31.2	9.02	
	US	Amorpha fruticosa	LIVE	50	1.0	0	
		Baccharis salicifolia	LIVE	125	1.0	0.01	
		Salix exigua	LIVE	550	1.0	0.04	
		Tamarix ramosissima	DEAD	125	11.2	1.23	
		Tamarix ramosissima	LIVE	25	5.0	0.05	
SOUTH 6	OS	Podulus deltoides	DEAD	12	41.0	1.58	2.67
	US	Podulus deltoides	LIVE	133	6.5	0.44	
		Tamarix ramosissima	DEAD	267	5.5	0.63	
		Forestiera pubescens	LIVE	67	1.0	0.01	

1. See Appendix 5.

2. Did count small exotic trees < 5 cm.

FUEL LOAD	TONS/AC DEAD-DOWN < 3"	TONS/AC DEAD-DOWN > 3"
SOUTH 5	4.43	19.16
SOUTH 6	5.32	10.06

Table 26. Middle Block Fire Effects Sites Vegetation and Fuel Load

SITE	OVERSTORY/ UNDERSTORY	SPECIES NAME 1.	DEAD/ LIVE	Plants/HA 2.	DBH cm	BA/HA m2	Site Basal Area
MIDDLE 5	OS	Populus deltoides	DEAD	194	43.7	29.10	30.75
		Salix gooddingii	DEAD	9	29.0	0.59	
	US	Populus deltoides	LIVE	100	5.0	0.10	
		Elaeagnus angustifolia	LIVE	50	6.0	0.07	
		Elaeagnus angustifolia	DEAD	300	8.0	0.75	
		Salix exigua	LIVE	2550	1.0	0.10	
		Salix gooddingii	LIVE	250	2.0	0.04	
MIDDLE 6	OS	Populus deltoides	DEAD	40	54.4	9.30	13.82
		Populus deltoides	LIVE	7	57.5	1.82	
	US	Populus deltoides	LIVE	1920	1.0	0.08	
		Elaeagnus angustifolia	DEAD	240	12.0	1.36	
		Elaeagnus angustifolia	LIVE	80	20.0	1.26	

1. See Appendix 5.

2. Did count small exotic trees < 5 cm.

FUEL LOAD	TONS/AC DEAD-DOWN < 3"	TONS/AC DEAD-DOWN > 3"
MIDDLE 5	0.41	0.15
MIDDLE 6	1.02	0

Table 27. Nesting success of Black-chinned Hummingbirds in exotic versus native plants (2000-01)

(Contingency table: not significant, $P > 0.05$.)

Substrate	Fail	Success	Total
Exotic	35	36	71
Native	18	12	30
Total	53	48	101

Appendix

Appendix 1.....	Prescription Guide for the Rio Grande Bosque
Appendix 2.....	Handbook of Wetland Vegetation Communities of New Mexico
Appendix 3.....	Middle Rio Grande Biological Survey
Appendix 4.....	Handbook of Inventorying Downed Woody Material
Appendix 5.....	Composite List of Plant Species
Appendix 6.....	Composite List of Bird Species (Migratory Status)
Appendix 7.....	Effects of Wildfire on the Flora and Fauna of Rio Grande Riparian Forests
Appendix 8.....	Joint Venture Agreement (RMRS –Research Work Unit 4351 and Oklahoma Biological Survey, University of Oklahoma)

PRESCRIPTION GUIDE
FOR
THE
RIO GRANDE BOSQUE

Objectives:

1. Maintain cottonwood - willow habitat
2. Reduce fires that convert cottonwood-willow habitat to other undesirable species.
3. Reclaim, and rehabilitate burned areas to maintain cottonwood-willow habitat.
 - a. Short term
 1. Rehabilitate fire lines.
 2. Treat fire line slash.
 3. Seed burn area with local native grasses to prevent erosion.
 - b. Long Term
 1. Remove non-native tree species.
 2. Remove non-habitat snags that are a hazard to public safety.
 3. Conduct tree and shrub plantings.

Ask local communities to identify areas of high priority in their area. Fire/Police Depts.

Determine plant community structure using Hink and Ohmart (1984) guide.

- C1 Mature Cottonwood stand 50-60 feet tall with density understory comprised of other species than cottonwood/coyote willow, examples are Russian olive, juniper, mulberry, elm etc. Very thick, hard to walk through, a lot of small diameter < 3" dead material, appears to be most flammable.
- C2 Mature Cottonwood stand 50-60 feet tall with sparse or lacking of other species. Easy to walk in a straight line. Stands provide best examples of resistant to catastrophic fires.
- C3 Intermediate size stand of cottonwoods, mature trees lacking, dense brush understory.
- C4 Young cottonwoods with smaller open understory species. Often associated with silty sand soils that support a crust of bluegreen algae and fungi. Soils should be preserved when located in the cottonwood Bosque.

- C5 Mature cottonwoods lacking, combination of non-cottonwood species. Dense vegetation up to 15 feet often with dense grasses and annuals. Tamarisk and other species are very dense, hard to walk through.
- C6 Low, often sparse vegetation, typical of sandbars with cottonwood, willow, and other seedlings, Edge effect between the riparian vegetation types and adjacent aquatic, wetland, upland, and agriculture areas

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GENERAL GUIDE LINES

1. Identify Stand by using Hink and Ohmart (1984) guide, ground reconnaissance, Arial photos.
2. Determine area/size of stand. A) 5 acres or less B) 5 acres or more.
3. Identify adjacent stands on either side of present stand by ground reconnaissance and/or arial photos.
4. Determine if there is a research study plot present, if present do not disturb area and notify landowner and or agency of study plot.
5. Determine if there are areas identified as "wildlife area". These areas should contain a greater density of downed logs in different stages of decomposition well distributed over the area.
6. Determine species make up of stand and protect for cottonwood and willow when possible by reducing vertical and horizontal fuels. Prune dead and green branched 4 feet up bole and create openings in the canopy.
 - a. There may be stands that are lacking cottonwood and willow.
 - b. Stands may consist of other species than Tamarisk (Tamarix ramosissima) Ledeb. The species may be pure or mixed in with the cottonwood (Populus fremontii var. wislizenii) and numerous willow species (Salix sp.) These other species could be comprised of Russian olive (Elaeagnus angustifolia), Siberian elm (Ulmus pumila), New Mexico olive (Forestiera neomexicana), Russian mulberry (Morus alba var. tatarica). There are other native shrubs that should be left for wildlife habitat and they are as follows: Indigo bush amorphia (Amorpha fruticosa), Golden currant (Ribes aurem); Willow baccharis (Baccharis salicina), and Anderson wolfberry (Lycium andersonii) to name a few.
 - c. Leave other species (No Tamarisk) whenever possible. Some examples are as follows:
 1. Russian olive 9" dbh and larger. Remove lower branches by pruning, four (4) to five (5) feet up from base of tree.
 2. Russian mulberry, keep single stem trees, no sap bleeding or open wounds, good health, little or no dead dominant and co-dominant branches.
 3. Black willow (Salix gooddingii) all diameter classes.
 4. There are areas where an escaped or exotic species may be found. I.E. honey-locust, oak, etc. Check with land owner as to cut or leave diameter classes of individual species,
7. Establish fuel breaks on major levee roads first.
 - a. Fuel breaks 1 to 2 chains depending on adjacent fuel loading along and across clear ditch and fields. This will be more critical on the west side of the river than on the east due to the southwest winds. The fuel break may extend from the levee road to edge of the clear ditch bank in most areas.

1. Draft
- b. Leave willow *sp.*, coyote, etc. (within the fuel break as they reduce the weed competition such as kochia (*Kochia scoparius*) and tumbleweeds (*Salsola pestifer*).
 8. Establish fuel breaks, using interior roads or trails when possible as designated by the landowner.
 - a. When constructing fuel breaks take advantage of the species Yerba mansa (*Anemopsis californica*) by placing the fuel break next to and along this species. It is a low growing plant 1 to 2 feet in height and found in moist areas.
 - b. Jetty-jacks may offer a fuel break by breaking stands into smaller compartments. Remove the material other than cottonwood/willow and Virginia creeper (*Parthenocissus inserta*) (feed for birds in autumn) from in and around these structures.
 9. When chipping, chip the green and dead material < 4 inches on the large end. The larger material bucked and piled. Blow chips back out on the ground with no large accumulation in any one area.
 10. Block or impede vehicle traffic on roads designated by the landowner.

C1 PRESCRIPTION

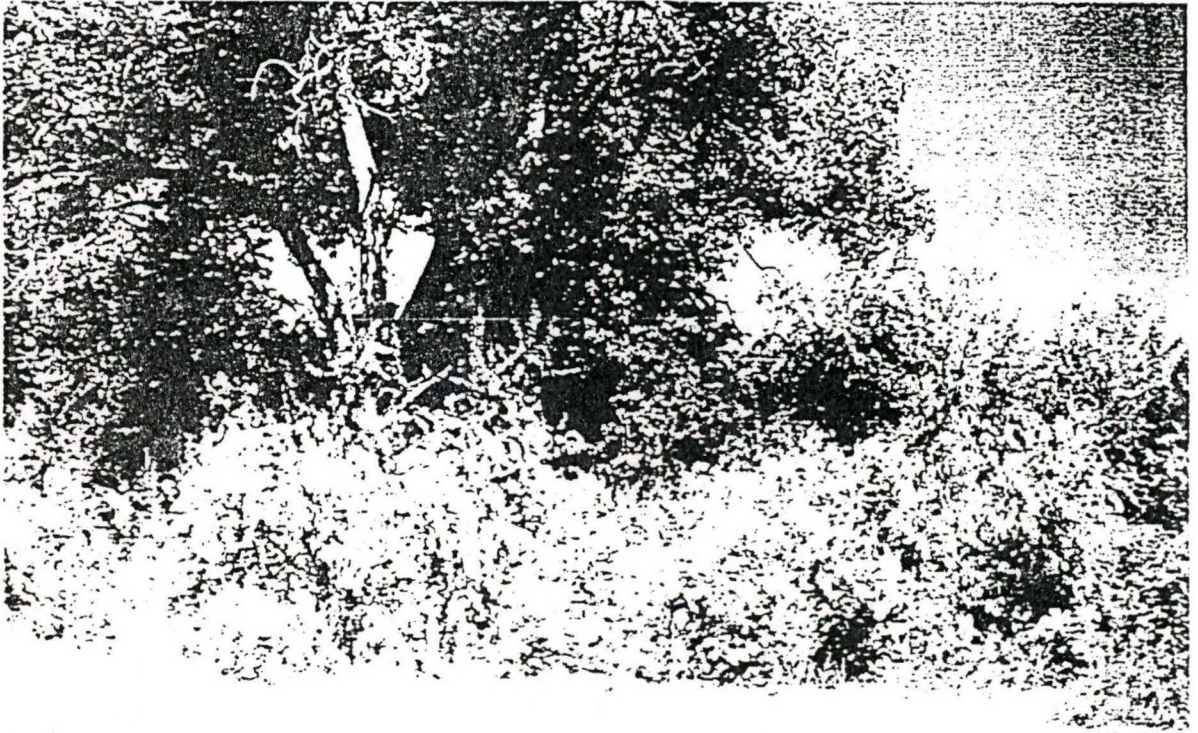
A) 5 acres or less

- a. Maintain Cottonwood - Willow Habitat
- b. Remove dead material > 3" diameter
- c. Remove ladder fuels from under cottonwoods and larger tree like willows(Coyote Willow is brush type, Black willow looks like a tree.
- d. Give consideration but not indiscriminate removal of snags and dead limbs for safety or appearance. Leave 2-3 per acre for cavity nesting birds, including snags along river edge.
- e. A minimum average of two downed logs per acre should be maintained. Protect larger downed 1000-hour fuels (12" + diameter small end) outside of canopy drip line by reducing fuel loading around logs four to six feet.
- f. Before starting, check with landowner for method of disposal. Material should be piled outside the canopy of cottonwoods and willows, chipped or cut into firewood.

B) 5 acres or more

- a. Create fuel breaks, utilizing existing roads/trails 1 to 2 chains on either side.
 1. First, levee roads as designated by landowner.
 2. Second, interior roads as designated by landowner.
- b. Create 1/2 to 3-acre size islands of different stand structures within these stands. This may allow a crown fire to become a surface fire. Incorporate depressions, oxbows into these islands. Protect cottonwood and willows by removing dead and non-native plants.
- c. Remove ladder fuels from under cottonwood and willow like trees outside of 1/2 to 3-acre size islands.
- d. Give consideration but not indiscriminate removal of snags and dead limbs for safety or appearance. Leave 2-3 snags per acre for cavity nesting birds. Including snags along the river.
- e. A minimum average of at least two downed logs per acre should be maintained. Protect larger downed 1000-hour fuels (14 "+ diameter small end cottonwood logs) outside of canopy drip line by reducing fuel loading from around cottonwood log four to six feet.

- f. Before starting check with landowner for disposal methods. Material should be piled outside the canopy of cottonwoods and willows, chipped or cut into firewood.
- g. Construct fuel break between stands, variable width not to exceed 2 chains and feather into each other.



C1

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C2 PRESCRIPTION

- a. Establish fuel breaks on major levee roads. 1 to 2 chains on either side.
- b. Establish fuel breaks using interior roads or trails as designed by the landowner, 1 chain on either side.
- c. Protect for cottonwood and willow.
- d. Remove non-native species.
- e. Give consideration but not indiscriminate removal of snags and dead limbs for safety or appearance. Leave 2-3 per acre for cavity nesting birds. Including snags along river edge.
- f. A minimum average of at least two downed logs per acre should be maintained. Protect larger downed 1000-hour (16"+ small end diameter logs) outside of canopy drip line by reducing fuels six to eight feet.
- g. Before starting, check with landowner for method of disposal. Material should be piled outside the canopy of cottonwoods and willows, chipped, or cut into firewood.

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C2

C3 PRESCRIPTION

- a. Establish fuel breaks on major levee roads, 1 to 2 chains on either side.
- b. Establish fuel breaks using interior roads or trails as designed by the landowner, 1 chain on either side.
- c. Protect for cottonwood and willow. Give additional consideration for young saplings and poles.
- d. Remove non-native species and ladder fuels from under cottonwoods and 2-3 chains from drip line of canopy.
- e. Look for islands of young cottonwoods. Remove all non-native species and dead material (100 hour fuels plus) from under canopy and 2 to 3 chains from drip line within these islands
- f. Give consideration but not indiscriminate removal of snags and dead limbs for safety or appearance. Leave 2-3 per acre for cavity nesting birds; including snags along river edge.
- f. A minimum of two downed logs per acre should be maintained. Protect larger downed 1000-hour fuels (16"+ diameter logs small end) by reducing fuel loading from around logs eight to ten feet.
- g. Before starting to cut check with landowner for method of disposal. Material should be piled outside the canopy of cottonwoods and willows, chipped, or cut into firewood.



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C3

C4 PRESCRIPTION

- a. Establish fuel breaks, utilizing existing roads/trails, 1 to 2 chains on either side.
- b. Establish fuel breaks using interior roads or trails as designed by the landowner, 1 chain on either side.
- c. Protect cottonwood and willow. Give additional consideration for young saplings and poles by removing ladder fuels and non-native species.
- d. Give consideration but not indiscriminate removal of snags and dead limbs for safety or appearance. Leave 2-3 per acre for cavity nesting birds. Including snags along river edge.
- e. A minimum of at least two downed logs should be maintained per acre. Protect larger downed 1000-hour fuels (16"+ diameter small end logs) by reducing fuel loading around logs by three to four feet. Keep distribution to a minimum in silty sand soils.
- f. Before starting, check with landowner for method of disposal. Material should be piled outside the canopy of cottonwoods and willows, chipped or cut into firewood.



Draft

C4

C5 PRESCRIPTION

- a. Look for islands of cottonwood and willows all ages in dense tamarisk stands.
 1. Remove all non-native species from under canopy of cottonwoods.
 2. Clear material 2-3 chains from drip line of canopy
 3. Give consideration, but not indiscriminate removal of snags and dead limbs for safety or appearance. Leave 2-3 snags per acre for cavity nesting birds. Including snags along river.
 4. A minimum of at least two downed logs should be maintained per acre. Protect larger downed 1000-hour fuels (16" + small end diameter cottonwood logs) ten to twelve feet around fuels and leave some 100-hour fuels (no more than 1/10 of total volume) by reducing fuel loading from around logs. Six to 10 feet. This is only in the cottonwood and willow islands.
- b. Establish fuel break using interior roads or trails as designed by the landowner. 1-2 chains on either side of road.
- c. Establish fuel breaks on major levee roads as designed by the landowner. 1-2 chains on either side of road.
 1. Before starting, check with landowner for method of disposal of material cut. Material should be piled outside the canopy of cottonwoods and willows, chipped, or cut into firewood.



C5

C6 DRAFT
PRESCRIPTION

There should be very little work done in this type of stand.

- a. Protect cottonwood and willow
- b. Remove non-native species from under canopy.
- c. Give consideration but not indiscriminate removal of snags and dead limbs for safety or appearance. Leave 2-3 snags per acre for cavity nesting birds; including snags along river.
- d. Protect larger downed 1000-hour fuels (8" diameter + small end) and some 100-hour fuels by reducing fuel loading from around material. Leave downed logs along river edge and in water for wildlife. Existing beaver population should be taken into account.

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Picture



C6

I



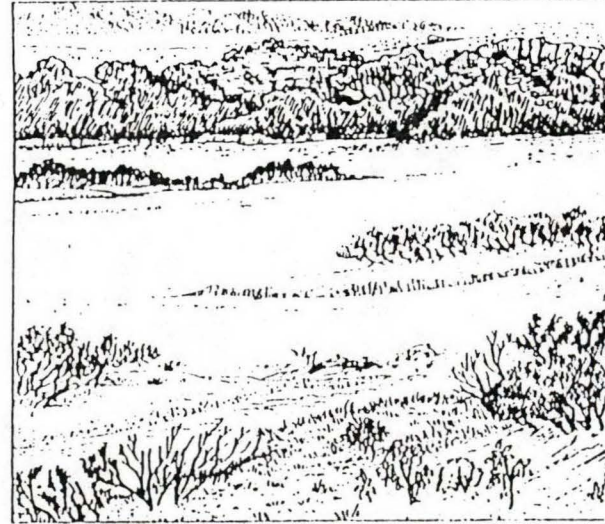
II



III



Illustration by WJU



IV

V

VI

References

Middle Rio Grande Ecosystem: Bosque Biological Management Plan. Biological Interagency Team, Clifford S. Crawford, Anne C. Cully, Rob Leutheuse, Mark S. Sifuentes, Larry H. White, James P. Wilber, Technical Coordinator Rayann E. Robino. October 1993.

Botanical Inventory of the Middle Rio Grande Bosque, Robert Sivinski, Greg Fitch, Anne Cully, Oct 1990.

An Assessment of Forest Ecosystem Health in the Southwest. USDA Forest Service Rocky Mountain Forest and Range Experiment Station. Southwestern Region. RM-GTR 295.

Handbook of Wetland Vegetation Communities of New Mexico

Volume I: Classification and Community Descriptions

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2000

Summary

In support of the New Mexico Wetlands Conservation Plan, this handbook was developed to aid inventory and assessment of the State's wetland vegetation communities. In *Volume I* a hierarchical vegetation classification is presented which provides detailed information about individual wetland plant community types of the state (including those of marshes, streamside riparian areas, playas, wet meadows, lakeshores, and peatlands). The classification system is based on six years of fieldwork concentrated in the major river basins of New Mexico, and on information from the literature. The study areas include the main stems and major tributaries of the Pecos, upper and middle Rio Grande, Gila, San Francisco, Mimbres, San Juan, Little Colorado, and Canadian Rivers within New Mexico. This classification identifies a total of 135 plant communities (or associations) which occur within 33 plant alliances (or series). The three major categories include forested wetlands (61 community types), scrub-shrub wetlands (38 community types), and emergent or herbaceous wetlands (36 community types). Descriptions for each community type include information addressing known geographic distribution, species composition, hydrological and soil characteristics, ecological dynamics, and conservation status. *Volume II* supports this document by describing reference sites where many of these plant communities may be found in relatively good condition. This two-volume reference represents the first major, statewide effort in developing a comprehensive vegetation classification for New Mexico wetlands. However, many of the community types described here are still considered "provisional" and will benefit from additional field inventory. User feedback is encouraged to enhance the classification and provide additional information on the status of these valuable economic and biological resources of the State.

Acknowledgements

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Key to the Forested Wetland Alliances

1. Blue spruce (*Picea pungens*), an evergreen conifer, well represented, and dominant or codominant in the overstory with broad-leaved deciduous trees.....**Blue Spruce Alliance**
1. Deciduous trees dominate the overstory, blue spruce accidental or absent(2)
2. Narrowleaf cottonwood (*Populus angustifolia*) or lanceleaf cottonwood (*P. acuminata*), abundant and dominant or codominant **Narrowleaf Cottonwood Alliance**
2. Narrowleaf or lanceleaf cottonwood poorly represented or absent (3)
3. Fremont cottonwood (*Populus fremontii*) abundant, or dominant or codominant **Fremont Cottonwood Alliance**
3. Fremont cottonwood absent or poorly represented and sub-dominant.....(4)
4. Arizona sycamore (*Platanus wrightii*) well represented to abundant, and dominant or codominant **Arizona Sycamore Alliance**
4. Arizona sycamore absent, or poorly represented and sub-dominant.....(5)
5. Arizona Alder (*Alnus oblongifolia*) abundant and dominant or codominant (southwestern New Mexico) **Arizona Alder Alliance**
5. Arizona alder, absent or sub-dominant to other trees.....(6)
6. Arizona walnut (*Juglans major*) abundant and dominant **Arizona Walnut Alliance**
6. Arizona walnut absent or poorly represented(7)
7. Boxelder (*Acer negundo*) abundant and dominant or codominant **Boxelder Alliance**
7. Boxelder uncommon or absent.....(8)
8. Plains or Rio Grande cottonwood (*Populus deltoides*) abundant and dominant or codominant **Plains Cottonwood Alliance**
8. Plains or Rio Grande cottonwood poorly represented or absent(9)
9. Goodding willow (*Salix gooddingii*) abundant or dominant; cottonwoods are poorly represented or absent..... **Goodding Willow Alliance**
9. Goodding willow absent, or if present, an understory sub-dominant(10)
10. Netleaf hackberry (*Celtis laevigata* var. *reticulata*) abundant and dominant.....**Netleaf Hackberry Alliance**
10. Netleaf hackberry absent, or poorly represented.....(11)
11. Russian olive (*Elaeagnus angustifolia*) abundant and dominant **Russian Olive Alliance**
11. Russian olive absent, or clearly subordinate to shrubs see Scrub-Shrub Wetlands Alliance Key, Page 85

Key to the Plains Cottonwood (Populus deltoides) Community Types:

1. Yerba mansa (*Anemopsis californica*) well represented, growing in mats on the forest floor.
..... **Plains Cottonwood/Yerba Mansa CT**
1. Yerba mansa poorly represented, scattered or absent (2)
2. Silver buffaloberry (*Shepherdia argentea*) abundant. Russian olive maybe well represented.....
..... **Plains Cottonwood/Silver Buffaloberry CT**
2. Silver buffaloberry absent or poorly represented (3)
3. New Mexico olive (*Forestiera pubescens* var. *pubescens*) well represented (4)
3. New Mexico olive scarce or absent (5)
4. Russian olive (*Elaeagnus angustifolia*) more dominant than New Mexico olive
..... **Plains Cottonwood-Russian Olive/New Mexico Olive CT**
4. New Mexico olive more dominant than Russian olive **Plains Cottonwood/New Mexico Olive CT**
5. Hoary rosemarymint (*Poliomintha incana*) well represented, and the dominant shrub; sand dunes
..... **Plains Cottonwood/Hoary Rosemarymint CT**
5. Not as above (6)
6. Willows (*Salix* spp.) well represented in the understory, and dominant or codominant in the shrub layer (7)
6. Willows poorly represented or absent in the understory (9)
7. Peachleaf willow (*Salix amygdaloides*) common to well represented
..... **Plains Cottonwood-Peachleaf Willow CT**
7. Peachleaf willow scarce or absent (8)
8. Goodding willow (*Salix gooddingii*) well represented to abundant, and the dominant sub-canopy tree or shrub
..... **Plains Cottonwood-Goodding Willow CT**
8. Goodding willow scarce or absent, not a dominant; coyote willow (*Salix exigua*) well represented to very
abundant, the dominant shrub; Russian olive and saltcedar (*Tamarix ramosissima*) may be present, but not
dominant **Plains Cottonwood/Coyote Willow CT**
9. Nebraska sedge (*Carex nebrascensis*) abundant **Plains Cottonwood/Nebraska Sedge CT**
9. Nebraska sedge absent or poorly represented (10)
10. Smooth horsetail (*Equisetum laevigatum*) common to abundant
..... **Plains Cottonwood/Smooth Horsetail CT**
10. Smooth horsetail scarce or absent (11)
11. Big sagebrush (*Artemisia tridentata*) abundant and the understory codominant
..... **Plains Cottonwood/Big Sagebrush CT**
11. Big sagebrush scarce or absent (12)
12. Rubber rabbitbrush (*Chrysothamnus nauseosus*) abundant and the understory codominant
..... **Plains Cottonwood/Rubber Rabbitbrush CT**
12. Rubber rabbitbrush scarce or absent (13)
13. New Mexico bluestem (*Schizachyrium neomexicanum*) well represented; gypsum dunes
..... **Plains Cottonwood/New Mexico Bluestem CT**
13. New Mexico bluestem scarce or absent (14)

14. Alkali sacaton well represented and dominant; sites open; soils alkaline; of bottomlands Plains Cottonwood/Alkali Sacaton CT
14. Alkali sacaton poorly represented and not dominant (15)
15. Sideoats grama (*Bouteloua curtipendula*) well represented and dominant Plains Cottonwood/Sideoats Grama CT
15. Sideoats grama poorly represented, not dominant (16)
16. Russian olive abundant, dominant or codominant with other sub-canopy trees or shrubs..... (17)
16. Russian olive not abundant, other shrubs or small trees dominate, or shrubs absent..... (18)
17. Russian olive dominates the sub-canopy and shrub layer, saltcedar is poorly represented or absent Plains Cottonwood-Russian Olive CT
17. Russian olive and saltcedar (*Tamarix ramosissima*) are abundant and codominate; understory sparse Plains Cottonwood-Russian Olive/Saltcedar CT
18. Saltcedar dominates the shrub layer..... Plains Cottonwood/Saltcedar CT
18. Saltcedar poorly represented (19)
19. Site recently flooded river bars and low terraces; understory sparse, or dominated by annual forbs..... Plains Cottonwood/Scour CT
19. Infrequently flooded terraces with cottonwood overstory, but understory generally sparse and shaded; woody and leaf debris may be thick on forest floor Plains Cottonwood/Sparse CT

Community Type Descriptions:

Common Name	Plains Cottonwood/Alkali Sacaton CT		
Scientific Name	<i>Populus deltoides</i> / <i>Sporobolus airoides</i> CT		
Acronym	POPDEL/SPOAIR	Status: Established	Rank: S2/G3
Distribution	Common in the Pecos River Basin in southeastern New Mexico, and occasional in the middle and lower Rio Grande.		

VEGETATION. Mature stands of Rio Grande or plains cottonwood have open to moderately open canopies with a grassy understory. Where trees are quite large (up to 1 m diameter at breast height) and old, the canopy may be very open, but the stand still maintains a large basal area. Reproduction of the native cottonwoods is rare or absent. Other trees are generally absent. The exotic saltcedar (*Tamarix ramosissima*) can occur as scattered shrubby individuals. Herbaceous diversity is moderate (44 species), and alkali sacaton dominates with 30% cover on average, and upwards to as much as 50%. Other grasses include sand dropseed (*Sporobolus cryptandrus*), other dropseeds (*Sporobolus* spp.), and Indian ricegrass (*Oryzopsis hymenoides*). The shrub layer is sparse to well represented with Emory falsewillow (*Baccharis emoryi*) often common, and, occasionally, rabbitbrush (*Chrysothamnus nauseosus*) and snakeweed (*Gutierrezia sarothrae*) are present. Forbs are sparse, and low to moderate in diversity (24 species known from the type). In addition to plains cottonwood, four other native wetland indicator species are known to occur in this community (*Baccharis emoryi*, *Distichlis spicata*, *Muhlenbergia asperifolia*, *Scirpus pungens*, and *Equisetum laevigatum*).

ENVIRONMENT. This community type occurs primarily along the broad valley floors of large river drainages with low gradient and sandy or silty riverbeds. Elevations are relatively low and are known to range from 3,550 to 4,575 ft (1,080 to 1,400 m). This community occurs mainly on low river terraces that are situated well above stream bankfull levels (discharge ratio well above one). Under unregulated conditions, these sites are probably inundated every 20 years on average. Where rivers are highly regulated, these sites are seldom flooded. The soils are young, poorly developed Entisols that may be sandy throughout, or have sandy or coarse loamy layers overlain by fine clay layers. They are moderate to well-drained. Soils are generally dry at the surface but become more moist with depth (1 m or more), particularly during seasonal high flows.

MIDDLE RIO GRANDE BIOLOGICAL SURVEY

Final Report

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APPENDIX XI.

VEGETATION TYPE MAPS OF THE STUDY AREA

Criteria Used in Vegetation Mapping

Community types were designated according to the dominant and/or codominant species in canopy and shrub layers. A species was considered dominant in a layer if it comprised at least 50% of the vegetation in that layer (by visual estimate). Codominants comprised at least 25% of a layer. From one to four species could potentially be listed for each layer, but typically there was a single canopy dominant (cottonwood) and one to three shrub (co)dominants. The species were listed in order of importance in each layer (separated by commas), and the species in the two layers were separated by a slash, e.g., C/RO,SC (after Radford 1978, cited in Dick-Peddie 1979).

Structure type designations followed the classification scheme discussed in the text. A key to the plant species abbreviations used in the maps, a brief description of each structure type, and a set of foliage profile diagrams are included here for reference.

Vegetation community and structural types are not discrete entities. Rather, they represent points along a continuum reflecting gradients in both species composition and three-dimensional foliage distribution. Hence, as in any classification system, not all stands were easily classified. Boundaries of types were sometimes difficult to draw because some stands graded from one community or structure type into another over some distance. Since a useful classification scheme cannot include all possible structure variations, we encountered some stands that were intermediate or that fit none of the types well. In such cases, subjective decisions had to be made. "Problem" stands were most frequently encountered in the intermediate-age structure types, III, IV, and V.

Similarly, a stand with a relatively uniform structure might vary in species composition, especially in the understory layer. An area of one structure type was not divided into two community types unless there was a distinct break or substantial difference in species composition across the stand. Instead, the different species were included as codominants.

Vegetation Structure Types

- Type I. Tall or mature to mixed-age class trees (≥ 40 ft) with well-developed understory vegetation. Substantial foliage in all height layers.
- Type II. Tall or mature trees (≥ 40 ft) with little or no understory vegetation. Majority of foliage above 30 ft.
- Type III. Intermediate-sized trees (20-40 ft) with dense understory vegetation. Majority of foliage between 0 and 30 ft.

- Type IV. Intermediate-sized (20-40 ft), openly spaced trees with little understory. Majority of foliage between 15 and 30 ft.
- Type V. Younger stands with dense shrubby growth. Majority of foliage between 0 and 10 or 15 ft.
- Type VI. Very young, low, and/or sparse stands. Majority of foliage between 0 and 5 ft.
- Scattered. Very sparsely distributed riparian vegetation.

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HANDBOOK FOR INVENTORYING DOWNED WOODY MATERIAL

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INTRODUCTION

This Handbook tells how to inventory weights, volumes, and depths of downed woody material. Downed woody material is the dead twigs, branches, stems, and boles of trees and brush that have fallen and lie on or above the ground. This material is usually called slash or logging debris if man creates it by cutting; it is called fuel, natural debris, or detritus if it accumulates without cutting.

Inventorying downed woody material can help land managers practice fuel management, plan for prescribed fire, and estimate utilization potential. For example, undesirable fuel hazards can be identified and plans made for hazard reduction. Fire behavior in wilderness areas can be predicted to aid in implementing let-burn fire policies. The volume of downed fiber can be estimated to plan for sales, removal, and utilization. Managers can communicate in exact terms about their debris problems.

The inventory can be done to provide all or any part of the following information:

1. Weights and volumes per acre of downed woody material for
 - a. Diameter size classes of 0 to 0.25, 0.25 to 1, and 1 to 3 inches; and
 - b. Diameters of 3 inches and larger for sound and rotten conditions.
2. Average diameter of debris larger than 3 inches.
3. Depth of fuel and forest floor duff.

This Handbook applies most accurately in the western United States because it contains average particle diameters for western conifers; however, the procedures are appropriate for forests everywhere. The inventory procedures are rapid and easy to

NUMBER AND SIZE OF SAMPLING PLANES

Choose sampling plane lengths from the following tabulation:

<i>Downed material</i>	<i>Diameter of debris</i>		
	<i>0-1 in</i>	<i>1-3 in</i>	<i>>3 in</i>
	<i>Sampling plane (ft)</i>		
Nonslash (naturally fallen material)	6	10-12	35-50
Discontinuous light slash	6	10-12	35-50
Continuous heavy slash	3	6	15-25

For any area where estimates are desired, 15 to 20 sample points should be located using the sampling plane lengths shown in the tabulation. This sampling intensity will often yield estimates having standard errors within 20 percent of the mean estimates. Areas larger than approximately 50 acres that contain a high diversity in amount and distribution of downed material should be sampled with more than 20 points. If material larger than 3 inches in diameter is scanty or unevenly distributed, the longer sampling planes in the tabulation should be used.

The amount and distribution of downed woody material vary greatly among and within stands. Thus, these sampling recommendations should be considered approximate because a greater or fewer number of plots may be required to furnish adequate precision for any given area. Sampling intensities are discussed further in Appendix I.

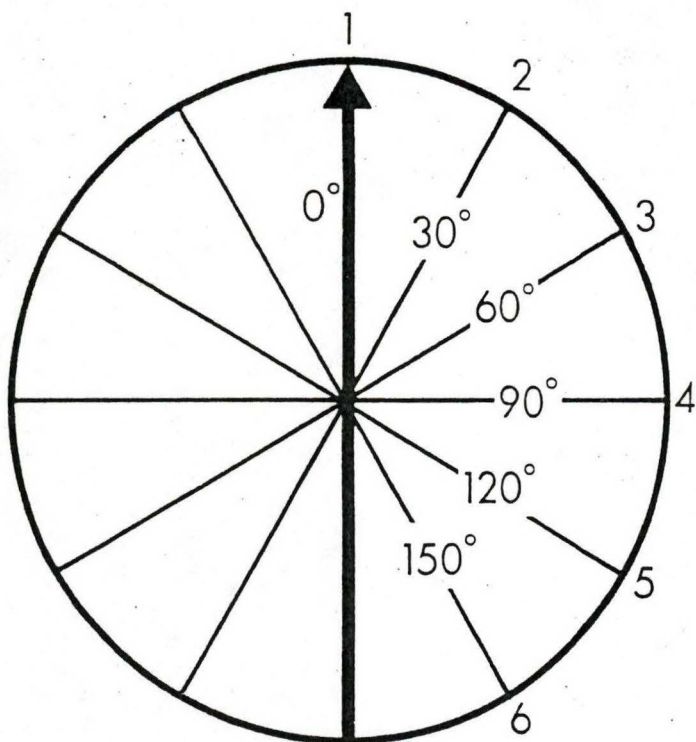


Figure 1.--Locating sampling plane by using die to pick one of six directions.

Step 3: Denote position of the sampling plane by running a tape or string out from the sampling point *parallel to the ground* in the direction determined in Step 2 (fig. 2). Extend the tape to the length of the longest sampling plane. A fiberglass rod or 1/2-inch aluminum tube placed along the string beginning at the sampling point facilitates counting pieces less than 1 inch in diameter. The rod should be 6 feet long, the length of sampling plane for small particles. The tape and rod fix the position of vertical sampling planes.

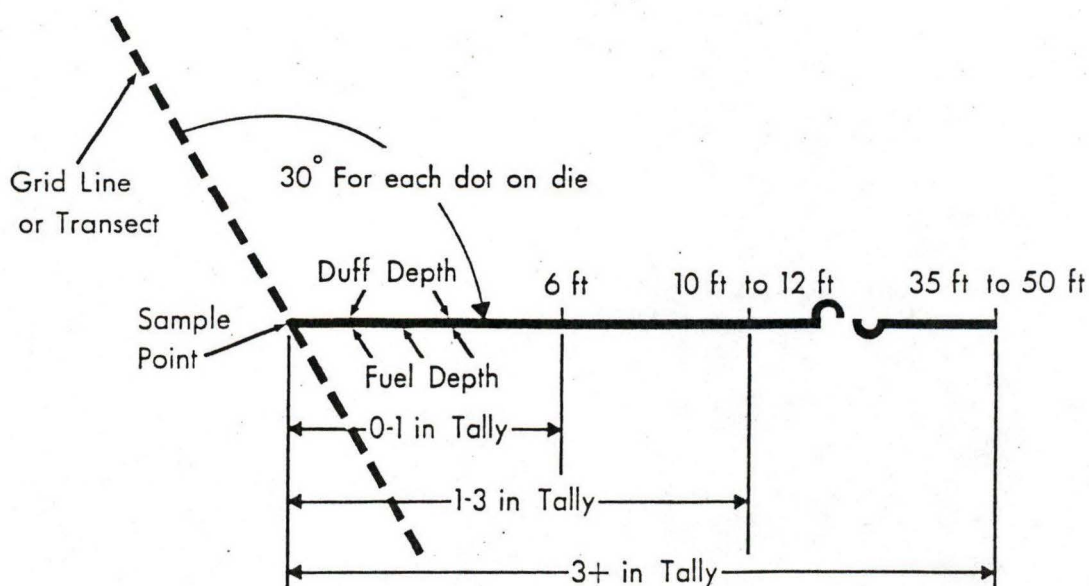
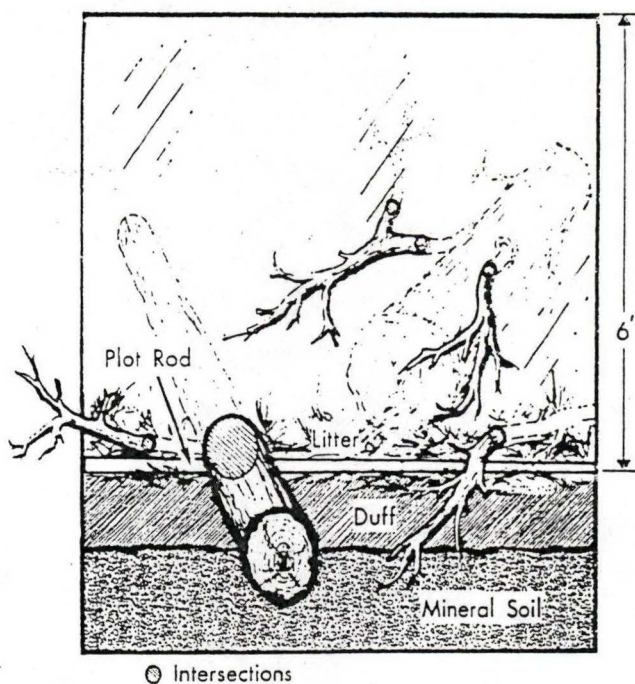


Figure 2.--Top view of sampling plane and location of fuel depth measurements.

Figure 4.--The sampling plane is exactly defined by one edge of the plot rod.



Step 6: Take three measurements of dead fuel depth. Record depth as the vertical distance from the bottom of the litter layer to the highest intersected dead particle for each of three adjacent 1-foot-wide vertical partitions of the sampling plane (fig. 5). Litter is the surface layer of the forest floor and consists of freshly fallen leaves, needles, twigs, bark, and fruits. Begin the vertical partitions at the sample point. Record to the nearest whole inch.

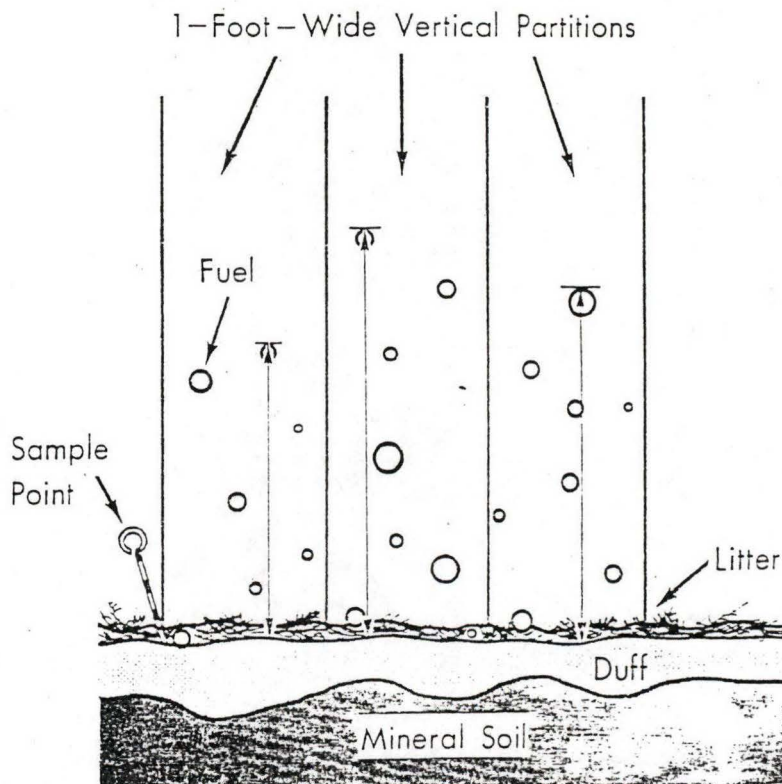


Figure 5.--Cross section of a fuel bed. Depth is measured along the arrows in each 1-foot-wide partition.

ruler. Calipers also work well for measuring diameter. A diameter tape, however, is unsatisfactory for pieces in contact with the ground.

Use as many consecutive lines on the data form (see page 14) as necessary to record diameters.

Step 9: For the entire sample area, record the predominate species of the 0- to 1-inch-diameter branchwood. An average diameter for the 0- to 0.25-inch, and 0.25- to 1-inch size classes will be selected from this information. If several species comprise the downed debris, estimate the proportion of the two or three most common species. Base this estimate on a general impression of what exists on the sample area and record as percentages of total 0- to 1-inch branchwood. Or, for a slight reduction in accuracy, omit this step and in the calculations use an average diameter for a composite of species (page 16).

TALLY RULES

The following rules apply to downed woody pieces of all diameters:

1. Particles qualifying for tally include *downed, dead* woody material (twigs, stems, branches, and bolewood) from trees and shrubs. Dead branches attached to boles of standing trees are omitted because they are not downed vegetation. Consider a particle downed when it has fallen to the ground or is severed from its original source of growth. Cones, bark flakes, needles, leaves, grass, and forbs are not counted. *Dead woody stems and branches still attached to standing brush and trees are not counted.*

2. Twigs or branches lying in the litter layer and above are counted. However, they are not counted when the intersection between the central axis of the particle and the sampling plane lies in the duff (forest floor below the litter) (fig. 7).

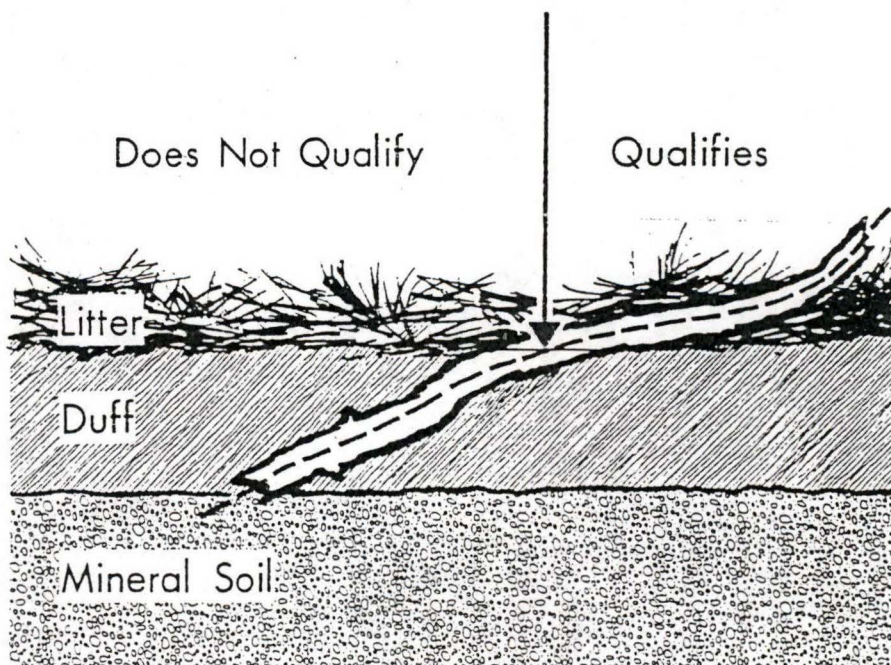


Figure 7.--Regardless of size, pieces are tallied only when intersection lies in and above the litter (right of arrow).

When standing trees are inventoried along with downed material, it is necessary to fix a limit above the ground for sampling downed material. An upper limit helps define a downed tree so that inventory of standing and downed materials will not overlap.^{1/}

HEAVY SLASH OPTIONS

1. A yardstick attached to a Jacob's staff is useful for marking the sampling plane and speeds the counting of small particles (fig. 10). Erect the Jacob's staff at the sample point. Aline the yardstick with the direction of the sample plane and level it using an attached bubble level.

Figure 10.--A yardstick or meter stick attached to a Jacob's staff defines the sampling plane in heavy slash.



2. In areas with considerable slash, sampling efficiency is improved by ocularly estimating the number of 0- to 0.25-inch intersections and actually counting the number of intersections at a subsample of points. The ocular estimates are adjusted using the ratio of ocular estimates-to-actual counts. This method, incorporating 3P sampling, is described in detail by Beaufait and others (1974).

^{1/}In the USDA Forest Service Northern Region, a rule has been established that a stem is "downed" and thus qualifies for tallying when the intersection of the sampling plane and central axis is 6 feet or less from the ground. If the midpoint of the bole is more than 6 feet above ground for trees encountered in fixed and variable radius plots, they are inventoried as "standing."

CALCULATIONS

The calculations can be readily processed by computer^{2/} and are also easy using a desk calculator. Sample calculations are shown in figures 12 and 13. For a given stand or sample area, fill in the computation summary sheet as follows:

1. Calculate the average slope correction factor (c) using slope correction factors for each sampling plane. Look up the correction factors in table 1 or compute them by:

$$c = \sqrt{1 + \left(\frac{\text{Percent slope}}{100}\right)^2}$$

No slope correction is needed for samples taken using the Jacob's staff.

Table 1.--*Slope correction factors for converting weight/acre on a slope basis to a horizontal basis*

Slope : Percent	Correction : factor <i>c</i>	Slope : Percent	Correction : factor <i>c</i>
0	1.00	60	1.17
10	1.00	70	1.22
20	1.02	80	1.28
30	1.04	90	1.35
40	1.08	100	1.41
50	1.12	110	1.49

^{2/} Card punching instructions and a FORTRAN program for computing the inventory results are available upon request from the Northern Forest Fire Laboratory, Drawer G, Missoula, Montana 59801.

DOWNED WOODY MATERIAL COMPUTATION SUMMARY

FOREST: _____ COMPARTMENT: _____ STAND: _____

Formulas to compute tons/acre:

$$(A) \text{ 0- to 3-inch material: } = \frac{11.64 \times n \times d^2 \times s \times a \times c}{Nl}$$

$$(B) \text{ 3+--inch material : } = \frac{11.64 \times Ed^2 \times s \times a \times c}{Nl}$$

Size class	Constant	n	d ²	s	a	c	Nl	Tons/acre	
0 - .25	<u>11.64</u>	<u>32</u>	<u>.0151</u>	<u>.48</u>	<u>1.13</u>	<u>1.08</u>	<u>12</u>	<u>.275</u>	I
.25 - 1	<u>11.64</u>	<u>11</u>	<u>.289</u>	<u>.48</u>	<u>1.13</u>	<u>1.08</u>	<u>12</u>	<u>1.81</u>	II
1 - 3	<u>11.64</u>	<u>3</u>	<u>2.76</u>	<u>.40</u>	<u>1.13</u>	<u>1.08</u>	<u>20</u>	<u>2.35</u>	III
		<u>Ed² for 3+</u>							
3+ Sound	<u>11.64</u>	<u>317</u>		<u>.40</u>	<u>1.0</u>	<u>1.08</u>	<u>70</u>	<u>22.8</u>	IV
3+ Rotten	<u>11.64</u>	<u>769</u>		<u>.30</u>	<u>1.0</u>	<u>1.08</u>	<u>70</u>	<u>41.4</u>	V
3+ Sound & Rotten = IV + V =								<u>64.2</u>	VI
Total = I + II + III + VI =								<u>68.6</u>	VII

	<u>Sum of 3+--inch diameters</u>	<u>Number of pieces</u>	<u>Average diameter</u>
Sound :	<u>33</u>	<u>4</u>	<u>8.25</u> in.
Rotten :	<u>37</u>	<u>2</u>	<u>18.5</u> in.
Sum of duff depths :	<u>4.5</u> in.		Sum of fuel depths : <u>40</u> in.
Number observations :	<u>4</u>		Number observations : <u>6</u>
Average duff depths :	<u>1.1</u> in.		Average fuel depths : <u>6.7</u> in.

Figure 13.--Computation summary sheet. The input values are from figure 12.

4. Determine specific gravity(s) of materials from known sources or from laboratory studies. Approximate specific gravities for conifers are:

Diameter class (inches):	0-0.25	0.25-1	1-3	3+Sound	3+Rotten
Specific gravity	: 0.48	0.48	0.40	0.40	0.30

Decay and variability in density make this variable difficult to handle with accuracy. More accurate estimates for large sound material can be obtained by using specific gravities from the USDA Forest Service (1955) *Wood Handbook*. Special studies, as shown in Appendix II, are needed to improve accuracy for the other particle categories.

5. For slash, determine the nonhorizontal angle correction factors (a) from table 3. For nonslash fuels, use the following correction factors based on a composite of western species:

0 to 3 inches: 1.13

3+ inches: 1.00

The correction factor adjusts weight estimates for the fact that all particles do not lie horizontally as assumed in the planar intersect theory.

Table 3.--Average secant of nonhorizontal particle angles for correcting orientation bias for slash

Size class (inches)	Species ^{1/}	Average (a)	
		Fresh slash	1-year and older slash
0 to 0.25	PP	1.25	1.25
	Others	1.40	1.15
0.25 to 1	PP	1.25	1.25
	Others	1.13	1.13
1 to 3	PP	1.22	1.22
	Others	1.10	1.10
3+	All (an assumption)	1.00	1.00

^{1/}PP=ponderosa pine; Others=based on data for Douglas-fir, lodgepole pine, Engelmann spruce, western redcedar, western larch, and grand fir.

6. Calculate the total length of sampling line ($N\ell$) for each size class: $N\ell$ = number of sample points multiplied by length of sampling plane (feet).

7. For material 3 inches and larger, square the diameter of each intersected piece and sum the squared values ($\sum d^2$) for all pieces in the sampled area.^{4/} Compute

^{4/}Ibid.

FURTHER APPLICATIONS

If only debris larger than 3 or 4 inches in diameter is to be inventoried, the line intersect technique described by Howard and Ward (1972) and Bailey (1969) might be more appropriate than the planar intersect method, especially in logging slash. The line intersect method employs a few long sampling planes; the planar intersect method employs many small sampling planes. If debris both greater than and less than 3 or 4 inches in diameter must be inventoried, the planar intersect technique is more efficient. The planar intersect technique can also be coordinated with other measurements of vegetation taken on plots (for example, an inventory of timber volume).

The procedures in this Handbook can be applied to downed debris in areas other than the western United States by assuming or measuring average diameters for the three size classes of particles. Average diameters have been determined for red pine (*Pinus resinosa*), jack pine (*Pinus banksiana*), and oak (*Quercus* spp.) (Brown and Roussopoulos 1974). A convenient method for estimating slash weights of several Lake States tree species has been reported by Roussopoulos and Johnson (1973).

If fire behavior is to be mathematically modeled using models such as Rothermel's (1972), weights of other fine fuels such as needle litter, dead grass, and dead forbs also should be determined by sampling or by extrapolating from existing information. Sampling for quantities of grass, forbs, and litter requires methods other than the planar intersect technique (USDA Forest Service 1959; Brown 1966; Hutchings and Schmutz 1969).

Because practical methods of inventory have been lacking in the past, accumulations of downed fuel and debris have been described in vague terms such as "light," "medium," and "heavy." Using the simple field procedures in this Handbook, weight and volume of downed woody material can be inventoried to provide an objective basis for managing debris.

APPENDIX I

Sampling Intensities

NUMBER AND SIZE OF SAMPLING PLANES

Sampling precision can be controlled by altering the number of plots and length of sampling planes. As a general rule, the more downed material on an area, the fewer the number and shorter the length of sampling planes required to achieve a given level of precision. Figure 14, based on average sampling variation for number of intersections of 0- to 1-inch and 1- to 3-inch particles, can help in choosing number of plots and length of sampling planes. The data for figure 14 are from many stands of varying composition and downed debris accumulations in northern Idaho and western Montana. Curves for all material under 3 inches in diameter would fall between those for the 0- to 1-inch and 1- to 3-inch classes.

Percent errors of 20 percent or less are probably adequate levels of precision for assessing most fuel problems. Percent error is the standard error of the estimate divided by the mean estimate and expressed as a percentage. More precision, such as percent errors of 10 to 15 percent, may be desirable for evaluating utilization potential of downed woody material.

Precision is maximized using a different length of sampling plane for each size class. However, considering both field effort and precision, it is more efficient to use the same plane length for sampling the 0- to 0.25- and 0.25- to 1-inch classes. The following suggestions will help determine the most efficient number and length of sampling planes for a given area:

1. Record data from about 20 sampling planes in an area and calculate the variation for guiding further sampling.

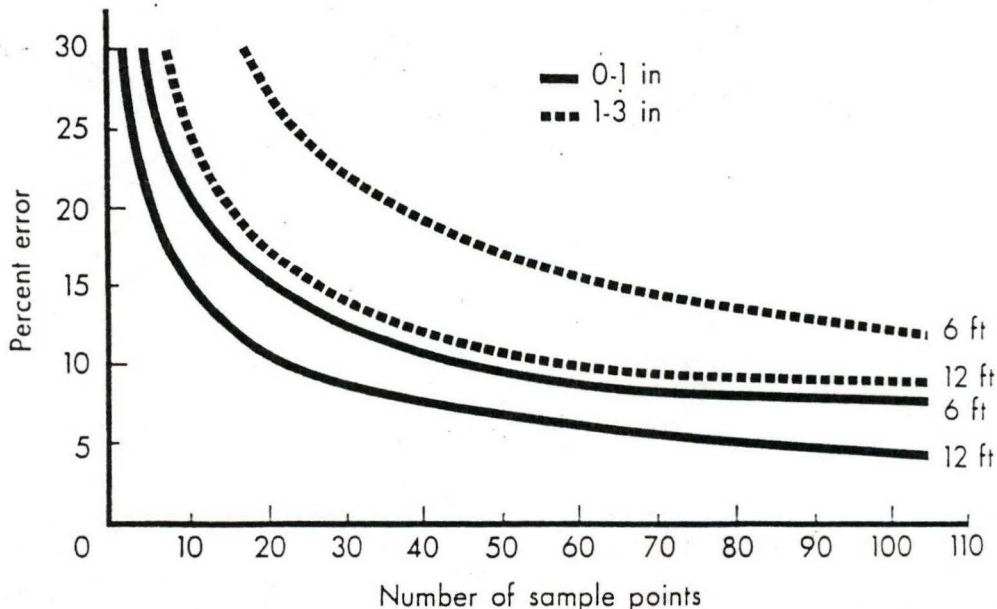


Figure 14.--Percent errors for number of particle intersections along 6- and 12-foot-length sampling planes related to number of sample points for quantities of light slash and nonslash. Percent error is 100X (standard error of the estimate divided by the mean estimate).

APPENDIX II

Specific Gravities of Sound Material

The specific gravities in table 4 are based on oven-dry weight and air-dry volume and can be used for calculation of loadings.

Table 4.--*Specific gravity of woody twigs
and branches with bark attached*

Species	Diameter size class (cm)				
	$\frac{1}{0} - 1$	$\frac{1}{1} - 10$	$\frac{2}{0} - 1$	$\frac{2}{1} - 3$	$\frac{2}{3} - 5$
Ponderosa pine	0.41	0.51	0.57	0.53	0.49
Douglas-fir	.55	.43	.56	.56	.52
Western larch	.46	.55			
Lodgepole pine	.49	.41			
Engelmann spruce	.34	.34			
Subalpine fir	.41	.40			
Western redcedar	.48	.33			

^{1/} William R. Beaufait and Charles E. Hardy. Fire quantification for silvicultural use. USDA For. Serv., Intermt. For. & Range Exp. Stn. (In preparation.)

^{2/} Brown (1972).

Appendix 5.	PLANTS		
COMMON NAME	SCIENTIFIC NAME	CLASS	KIND
Box elder	Acer negundo	TREE	NATIVE
Tree of Heaven	Ailanthus altissima	TREE	EXOTIC
Russian olive	Elaeagnus angustifolia	TREE	EXOTIC
Honey locust	Gleditsia triacanthos	TREE	EXOTIC
Oneseed juniper	Juniperus monosperma	TREE	NATIVE
White mulberry	Morus alba	TREE	EXOTIC
Rio Grande cottonwood	Populus deltoides	TREE	NATIVE
Screwbean mesquite	Prosopis pubescens	TREE	NATIVE
Goodding's willow	Salix gooddingii	TREE	NATIVE
Tamarisk	Tamarix ramosissima	TREE	EXOTIC
Siberian elm	Ulmus pumila	TREE	EXOTIC
Indigo bush	Amorpha fruticosa	SHRUB	NATIVE
Sand sage	Artemisia filifolia	SHRUB	NATIVE
Four-wing salt bush	Atriplex canescens	SHRUB	NATIVE
Seepwillow	Baccharis salicifolia	SHRUB	NATIVE
Rio Grande Seepwillow	Baccharis salicina	SHRUB	NATIVE
Spreading rabbitbush	Chrysothamnus linifolius	SHRUB	NATIVE
New Mexico olive	Forestiera pubescens	SHRUB	NATIVE
Broom snakeweed	Gutierrezia sarothrae	SHRUB	NATIVE
Pale wolfberry	Lycium pallidum	SHRUB	NATIVE
Virginia creeper	Parthenocissus quinquefolia	SHRUB	NATIVE
Golden currant	Ribes aureum	SHRUB	NATIVE
Coyote willow	Salix exigua	SHRUB	NATIVE
Russian knapweed	Acroptilon repens	FORB	EXOTIC
Pigweed	Amaranthus hybridus	FORB	NATIVE
Carelessweed	Amaranthus palmeri	FORB	NATIVE
Ragweed	Ambrosia acanthicarpa	FORB	NATIVE
Western ragweed	Ambrosia psilostachya	FORB	NATIVE
Yerba mansa	Anemopsis californica	FORB	NATIVE
Silverweed cinquefoil	Argentina anserina	FORB	NATIVE
Spurred anoda	Anoda cristata	FORB	EXOTIC
Spreading dogbane	Apocynum androsaemifolium	FORB	NATIVE
Lesser burdock	Arctium minus	FORB	EXOTIC
Field sagewort	Artemisia campestris	FORB	NATIVE
Louisiana sagewort	Artemisia ludoviciana	FORB	NATIVE
Showy milkweed	Asclepias speciosa	FORB	NATIVE
Whorled milkweed	Asclepias subverticillata	FORB	NATIVE
Butterfly milkweed	Asclepias tuberosa	FORB	NATIVE
Asparagus	Asparagus officinale	FORB	EXOTIC
Heath aster	Aster ericoides	FORB	NATIVE
Crescent Milkvetch	Astragalus amphioxys	FORB	NATIVE
Bur marigold	Bidens cernua	FORB	EXOTIC
Hoary cress	Cardaria draba	FORB	EXOTIC
COMMON NAME	SCIENTIFIC NAME	CLASS	KIND

Arizona centaury	<i>Centaurium calycosum</i>	FORB	NATIVE
Spotted spurge	<i>Chamaesyce maculata</i>	FORB	NATIVE
Matted sandmat	<i>Chamaesyce serpens</i>	FORB	NATIVE
Lambquarters	<i>Chenopodium album</i>	FORB	NATIVE
Narrowleaf goosefoot	<i>Chenopodium leptopyllum</i>	FORB	NATIVE
Mexican devilweed	<i>Chloracantha spinosa</i>	FORB	NATIVE
Water hemlock	<i>Cicuta douglasii</i>	FORB	NATIVE
Drummond's clematis	<i>Clematis drummondii</i>	FORB	NATIVE
Bindweed	<i>Convolvulus arvensis</i>	FORB	NATIVE
Canadian horseweed	<i>Conyza canadensis</i>	FORB	NATIVE
Texas croton	<i>Croton texensis</i>	FORB	NATIVE
Bow-nut cryptantha	<i>Cryptantha cinerea</i>	FORB	NATIVE
Buffalo gourd	<i>Cucurbita foetidissima</i>	FORB	NATIVE
White prairie clover	<i>Dalea candida</i>	FORB	NATIVE
Woolly prairieclover	<i>Dalea lanata</i>	FORB	NATIVE
Oak-leaved thornapple	<i>Datura ferox</i>	FORB	NATIVE
Jimsonweed	<i>Datura wrightii</i>	FORB	NATIVE
Flixweed	<i>Descurainia sophia</i>	FORB	EXOTIC
Prairie bundleflower	<i>Desmanthus illinoensis</i>	FORB	NATIVE
Smooth horsetail	<i>Equisetum laevigatum</i>	FORB	NATIVE
Spreading fleabane	<i>Erigeron divergens</i>	FORB	NATIVE
Redstem stork's bill	<i>Erodium cicutarium</i>	FORB	EXOTIC
Spurge species?	<i>Euphorbia species?</i>	FORB	NATIVE
Richardson geranium	<i>Geranium richardsonii</i>	FORB	NATIVE
Wild licorice	<i>Glycyrrhiza lepidota</i>	FORB	NATIVE
Cottonbatting cudweed	<i>Gnaphalium stramineum</i>	FORB	NATIVE
Curlytop gumweed	<i>Grindelia nuda</i>	FORB	NATIVE
Curlycup gumweed	<i>Grindelia squarrosa</i>	FORB	NATIVE
Small-flowered guara	<i>Guara parviflora</i>	FORB	NATIVE
English ivy	<i>Hedera helix</i>	FORB	EXOTIC
Annual sunflower	<i>Helianthus annuus</i>	FORB	NATIVE
Texas blueweed	<i>Helianthus ciliaris</i>	FORB	NATIVE
Maximilian sunflower	<i>Helianthus maximiliani</i>	FORB	NATIVE
Prairie sunflower	<i>Helianthus petiolaris</i>	FORB	NATIVE
Showy goldeneye	<i>Heliomeris multiflora</i>	FORB	NATIVE
Hairy golden aster	<i>Heterotheca villosa</i>	FORB	NATIVE
Hog potato	<i>Hoffmannsegia glauca</i>	FORB	NATIVE
White ragweed	<i>Hymenopappus filifolius</i>	FORB	NATIVE
Trumpet gilia	<i>Ipomopsis longiflora</i>	FORB	NATIVE
Summer cypress	<i>Kochia scoparia</i>	FORB	EXOTIC
Prickly lettuce	<i>Lactuca serriola</i>	FORB	NATIVE
Perennial pepperweed	<i>Lepidium latifolium</i>	FORB	EXOTIC
Lacy tansyaster	<i>Machaeranthera pinnatifida</i>	FORB	NATIVE
Small-flowered aster	<i>Machaeranthera tanacetifolia</i>	FORB	NATIVE
Horehound	<i>Marrubium vulgare</i>	FORB	EXOTIC
Alfalfa	<i>Medicago sativa</i>	FORB	EXOTIC
White sweet clover	<i>Melilotus albus</i>	FORB	NATIVE
COMMON NAME	SCIENTIFIC NAME	CLASS	KIND

Catnip	Nepeta cataria	FORB	EXOTIC
Stemless evening primrose	Oenothera caespitosa	FORB	NATIVE
Pink evening primrose	Oenothera coronopifolia	FORB	NATIVE
Missouri evening primrose	Oenothera macrocarpa	FORB	NATIVE
Palafoxia	Palafoxia sphacelata	FORB	NATIVE
Sand penstemon	Penstemon ambiguus	FORB	NATIVE
Ivy-leaved groundcherry	Physalis hederifolia	FORB	NATIVE
Virginia groundcherry	Physalis virginiana	FORB	NATIVE
Common Plantain	Plantago major	FORB	EXOTIC
Sandyseed clammyweed	Polanisia dodendra	FORB	NATIVE
New Mexico purslane	Portulaca oleracea	FORB	NATIVE
Water crowfoot	Ranunculus aquatilis	FORB	NATIVE
Short-rayed coneflower	Ratibida tagetes	FORB	NATIVE
Curley dock	Rumex crispus	FORB	EXOTIC
Thumbleweed	Salsola kali	FORB	EXOTIC
Lance-leaved sage	Salvia reflexa	FORB	NATIVE
Douglas groundsel	Senecio flaccidus	FORB	NATIVE
Riddell's groundsel	Senecio riddellii	FORB	NATIVE
London Rocket	Sisymbrium irio	FORB	NATIVE
Arizona nightshade	Solanum douglasii	FORB	NATIVE
Silverleaf nightshade	Solanum elaeagnifolium	FORB	NATIVE
Wild potato	Solanum jamesii	FORB	NATIVE
Canada goldenrod	Solidago canadensis	FORB	NATIVE
Narrow goldenrod	Solidago simplex	FORB	NATIVE
Spiny sowthistle	Sonchus asper	FORB	EXOTIC
Desert hollyhock	Sphaeralcea ambigua	FORB	NATIVE
Narrowleaf globemallow	Sphaeralcea angustifolia	FORB	NATIVE
Fendler globemallow	Sphaeralcea fendleri	FORB	NATIVE
Red bladderpod	Sphaerophysa salsula	FORB	NATIVE
Common dandelion	Taraxacum officinale	FORB	NATIVE
Greenthread	Thelesperma megaapotamicum	FORB	NATIVE
Goathead	Tribulus terrestris	FORB	EXOTIC
White clover	Trifolium repens	FORB	EXOTIC
Common mullein	Verbascum thapsus	FORB	EXOTIC
Cowpen daisy	Verbesina encelioides	FORB	NATIVE
Rough cocklebur	Xanthium strumarium	FORB	NATIVE
Redtop	Agrostis gigantea	GRASS	EXOTIC
Purple three-awn	Aristida purpurea	GRASS	NATIVE
Silver bluestem	Bithrichloa laguroides	GRASS	NATIVE
Six-weeks grama	Bouteloua barbata	GRASS	NATIVE
Sideoats grama	Bouteloua curtipendula	GRASS	NATIVE
Hairy grama	Bouteloua hirsuta	GRASS	NATIVE
Cheatgrass	Bromus tectorum	GRASS	EXOTIC
Feather fingergrass	Chloris virgata	GRASS	NATIVE
Bermuda grass	Cynodon dactylon	GRASS	EXOTIC
Saltgrass	Distichlis spicata	GRASS	NATIVE
COMMON NAME	SCIENTIFIC NAME	CLASS	KIND
Barnyard grass	Echinochloa crus-galli	GRASS	EXOTIC

Canadian wildrye	<i>Elymus canadensis</i>	GRASS	NATIVE
Squirreltail bottlebrush	<i>Elymus elymoides</i>	GRASS	NATIVE
Blue wildrye	<i>Elymus glaucus</i>	GRASS	NATIVE
Slender wheatgrass	<i>Elymus trachycaulus</i>	GRASS	NATIVE
Tall wheatgrass	<i>Elytrigia elongata</i>	GRASS	EXOTIC
Intermediate wheatgrass	<i>Elytrigia intermedia</i>	GRASS	EXOTIC
Wolf tail	<i>Lycurus phleoides</i>	GRASS	EXOTIC
Alkahli muhly	<i>Muhlenbergia asperifolia</i>	GRASS	NATIVE
Indian rice grass	<i>Oryzopsis hymenoides</i>	GRASS	NATIVE
Witch grass	<i>Panicum capillare</i>	GRASS	NATIVE
Vine-mesquite	<i>Panicum obtusum</i>	GRASS	NATIVE
Switchgrass	<i>Panicum virgatum</i>	GRASS	NATIVE
Common reed	<i>Phragmites australis</i>	GRASS	NATIVE
Fowl bluegrass	<i>Poa palustris</i>	GRASS	NATIVE
Kentucky bluegrass	<i>Poa pratensis</i>	GRASS	NATIVE
Rabbitsfoot grass	<i>Polypogon monspeliensis</i>	GRASS	EXOTIC
Green bristlegram	<i>Setaria viridis</i>	GRASS	EXOTIC
Johnson grass	<i>Sorghum halepense</i>	GRASS	EXOTIC
Alkali sacaton	<i>Sporobolus airoides</i>	GRASS	NATIVE
Spike dropseed	<i>Sporobolus contractus</i>	GRASS	NATIVE
Sand dropseed	<i>Sporobolus cryptandrus</i>	GRASS	NATIVE
Six-weeks fescue	<i>Vulpia octoflora</i>	GRASS	NATIVE
Macoun wildrye cross	<i>X Elyhordeum macounii</i>	GRASS	NATIVE
Common spikerush	<i>Eleocharis palustris</i>	RUSH	NATIVE
Wire rush	<i>Juncus mexicanus</i>	RUSH	NATIVE
Hardstem bulrush	<i>Scirpus acutus</i>	RUSH	NATIVE
Narrow-leaved cattail	<i>Typha angustifolia</i>	RUSH	NATIVE
Cattail species?	<i>Typha species?</i>	RUSH	NATIVE
Water sedge	<i>Carex aquatilis</i>	SEDGE	NATIVE
Clustered field sedge	<i>Carex praegracilis</i>	SEDGE	NATIVE
Three square	<i>Schoenoplectus americanus</i>	SEDGE	NATIVE

Appendix 6.		BIRD SPECIES		
AOU#	COMMON NAME	GENUS NAME	SPECIES NAME	MIGRATION STATUS
0060	Pied-billed Grebe	Podilymbus	podiceps	NEOTROPICAL
0540	Ring-billed Gull	Larus	delawarensis	SHORT DISTANCE
1200	Double-crested Cormorant	Phalacrocorax	auritus	SHORT DISTANCE
1210	Neotropic Cormorant	Phalacrocorax	olivaceus	RESIDENT
1320	Mallard	Anas	platyrhynchos	SHORT DISTANCE
1350	Gadwall	Anas	strepera	SHORT DISTANCE
1390	American Green-winged Teal	Anas	crecca	SHORT DISTANCE
1440	Wood Duck	Aix	sponsa	SHORT DISTANCE
1720	Canada Goose	Branta	canadensis	SHORT DISTANCE
1870	White-faced Ibis	Plegadis	chihi	SHORT DISTANCE
1940	Great Blue Heron	Ardea	herodias	SHORT DISTANCE
1960	Great Egret	Ardea	alba	SHORT DISTANCE
1970	Snowy Egret	Egretta	thula	SHORT DISTANCE
2001	Cattle Egret	Bubulcus	ibis	SHORT DISTANCE
2010	Green Heron	Butorides	virescens	SHORT DISTANCE
2020	Black-crowned Night-Heron	Nycticorax	nycticorax	SHORT DISTANCE
2210	American Coot	Fulica	americana	SHORT DISTANCE
2250	American Avocet	Recurvirostra	americana	SHORT DISTANCE
2260	Black-necked Stilt	Himantopus	mexicanus	SHORT DISTANCE
2300	Wilson's Snipe	Gallinago	delicata	SHORT DISTANCE
2630	Spotted Sandpiper	Actitis	macularia	SHORT DISTANCE
2730	Killdeer	Charadrius	vociferus	SHORT DISTANCE
3160	Mourning Dove	Zenaida	macroura	SHORT DISTANCE
3190	White-winged Dove	Zenaida	asiatica	CROSS BORDER
3250	Turkey Vulture	Cathartes	aura	SHORT DISTANCE
3330	Cooper's Hawk	Accipiter	cooperii	SHORT DISTANCE
3370	Red-tailed Hawk	Buteo	jamaicensis	SHORT DISTANCE
3420	Swainson's Hawk	Buteo	swainsoni	NEOTROPICAL
3480	Ferruginous Hawk	Buteo	regalis	SHORT DISTANCE
3600	American Kestrel	Falco	sparverius	SHORT DISTANCE
3732	Western Screech-Owl	Otus	kennicottii	SHORT DISTANCE
3750	Great Horned Owl	Bubo	virginianus	SHORT DISTANCE
3850	Greater Roadrunner	Geococcyx	californianus	RESIDENT
3870	Yellow-billed Cuckoo	Coccyzus	americanus	NEOTROPICAL
3900	Belted Kingfisher	Ceryle	alcyon	SHORT DISTANCE
3930	Hairy Woodpecker	Picoides	villosus	SHORT DISTANCE
3940	Downy Woodpecker	Picoides	pubescens	SHORT DISTANCE
3960	Ladder-backed Woodpecker	Picoides	scalaris	SHORT DISTANCE
4080	Lewis' Woodpecker	Melanerpes	lewis	SHORT DISTANCE
4130	Northern Flicker	Colaptes	auratus	SHORT DISTANCE
4200	Common Nighthawk	Chordeiles	minor	NEOTROPICAL
4290	Black-chinned Hummingbird	Archilochus	alexandri	NEOTROPICAL
4320	Broad-tailed Hummingbird	Selasphorus	platycercus	NEOTROPICAL
4330	Rufous Hummingbird	Selasphorus	rufus	NEOTROPICAL
4470	Western Kingbird	Tyrannus	verticalis	NEOTROPICAL

AOU#	COMMON NAME	GENUS NAME	SPECIES NAME	MIGRATION STATUS
4540	Ash-throated Flycatcher	Myiarchus	cinerascens	NEOTROPICAL
4580	Black Phoebe	Sayornis	nigricans	SHORT DISTANCE
4620	Western Wood-Pewee	Contopus	sordidulus	NEOTROPICAL
4640	Cordilleran Flycatcher	Empidonax	occidentalis	NEOTROPICAL
4660	Willow Flycatcher	Empidonax	traillii	NEOTROPICAL
4690	Dusky Flycatcher	Empidonax	oberholseri	NEOTROPICAL
4750	Black-billed Magpie	Pica	pica	SHORT DISTANCE
4810	Western Scrub-Jay	Aphelocoma	californica	RESIDENT
4860	Common Raven	Corvus	corax	SHORT DISTANCE
4870	Chihuahuan Raven	Corvus	cryptoleucus	SHORT DISTANCE
4880	American Crow	Corvus	brachyrhynchos	SHORT DISTANCE
4920	Pinyon Jay	Gymnorhinus	cyanocephalus	SHORT DISTANCE
4930	European Starling	Sturnus	vulgaris	SHORT DISTANCE
4950	Brown-headed Cowbird	Molothrus	ater	SHORT DISTANCE
4980	Red-winged Blackbird	Agelaius	phoeniceus	SHORT DISTANCE
5010	Eastern Meadowlark	Sturnella	magna	SHORT DISTANCE
5011	Western Meadowlark	Sturnella	neglecta	SHORT DISTANCE
5080	Bullock's Oriole	Icterus	galbula	SHORT DISTANCE
5100	Brewer's Blackbird	Euphagus	cyanocephalus	SHORT DISTANCE
5110	Common Grackle	Quiscalus	quiscula	SHORT DISTANCE
5120	Great-tailed Grackle	Quiscalus	mexicanus	SHORT DISTANCE
5140	Evening Grosbeak	Coccothraustes	vespertinus	SHORT DISTANCE
5190	House Finch	Carpodacus	mexicanus	SHORT DISTANCE
5290	American Goldfinch	Carduelis	tristis	SHORT DISTANCE
5300	Lesser Goldfinch	Carduelis	psaltria	SHORT DISTANCE
5330	Pine Siskin	Caduelis	pinus	SHORT DISTANCE
5520	Lark Sparrow	Chondestes	grammacus	NEOTROPICAL
5600	Chipping Sparrow	Spizella	passerina	NEOTROPICAL
5880	Spotted Towhee	Pipilo	maculatus	SHORT DISTANCE
5950	Rose-breasted Grosbeak	Pheucticus	ludovicianus	NEOTROPICAL
5960	Black-headed Grosbeak	Pheucticus	melanocephalus	NEOTROPICAL
5970	Blue Grosbeak	Passerina	caerulea	NEOTROPICAL
5980	Indigo Bunting	Passerina	cyanea	NEOTROPICAL
5990	Lazuli Bunting	Passerina	amoena	NEOTROPICAL
6070	Western Tanager	Piranga	ludoviciana	NEOTROPICAL
6100	Summer Tanager	Piranga	rubra	NEOTROPICAL
6120	Cliff Swallow	Hirundo	pyrrhonota	NEOTROPICAL
6130	Barn Swallow	Hirundo	rustica	NEOTROPICAL
6160	Bank Swallow	Riparia	riparia	NEOTROPICAL
6170	Northern Rough-winged Swallow	Stelgidopteryx	serripennis	NEOTROPICAL
6200	Phainopepla	Phainopepla	nitens	RESIDENT
6270	Warbling Vireo	Vireo	gilvus	NEOTROPICAL
6291	Plumbeous Vireo	Vireo	plumbeus	NEOTROPICAL
6292	Cassin's Vireo	Vireo	cassinii	NEOTROPICAL
6299	Solitary Vireo	Vireo	solitarius	NEOTROPICAL
6310	White-eyed Vireo	Vireo	griseus	NEOTROPICAL
6330	Bell's Vireo	Vireo	bellii	NEOTROPICAL

AOU#	COMMON NAME	GENUS NAME	SPECIES NAME	MIGRATION STATUS
6360	Black-and-white Warbler	Mniotilta	varia	NEOTROPICAL
6370	Prothonotary Warbler	Protonotaria	citrea	NEOTROPICAL
6430	Lucy's Warbler	Vermivora	luciae	CROSS BORDER
6440	Virginia's Warbler	Vermivora	virginiae	NEOTROPICAL
6460	Orange-crowned Warbler	Vermivora	celata	NEOTROPICAL
6520	Yellow Warbler	Dendroica	petechia	NEOTROPICAL
6556	Yellow-rumped Warbler	Dendroica	coronata	SHORT DISTANCE
6740	Ovenbird	Seiurus	aurocapillus	NEOTROPICAL
6770	Kentucky Warbler	Oporornis	formosus	NEOTROPICAL
6800	MacGillivray's Warbler	Oporornis	tolmiei	NEOTROPICAL
6810	Common Yellowthroat	Geothlypis	trichas	NEOTROPICAL
6830	Yellow-breasted Chat	Icteria	virens	NEOTROPICAL
6840	Hooded Warbler	Wilsonia	citrina	NEOTROPICAL
6850	Wilson's Warbler	Wilsonia	pusilla	NEOTROPICAL
6882	House Sparrow	Passer	domesticus	SHORT DISTANCE
7030	Northern Mockingbird	Mimus	polyglottos	SHORT DISTANCE
7040	Gray Catbird	Dumetella	carolinensis	NEOTROPICAL
7190	Bewick's Wren	Thryomanes	bewickii	SHORT DISTANCE
7210	House Wren	Troglodytes	aedon	NEOTROPICAL
7250	Marsh Wren	Cistothorus	palustris	SHORT DISTANCE
7270	White-breasted Nuthatch	Sitta	carolinensis	SHORT DISTANCE
7280	Red-breasted Nuthatch	Sitta	canadensis	SHORT DISTANCE
7350	Black-capped Chickadee	Poecile	atricapilla	SHORT DISTANCE
7380	Mountain Chickadee	Poecile	gambeli	SHORT DISTANCE
7430	Bushtit	Psaltiriparus	minimus	SHORT DISTANCE
7460	Verdin	Auriparus	flaviceps	SHORT DISTANCE
7490	Ruby-crowned Kinglet	Regulus	calendula	SHORT DISTANCE
7510	Blue-gray Gnatcatcher	Poliophtila	caerulea	SHORT DISTANCE
7580	Swainson's Thrush	Catharus	ustulatus	NEOTROPICAL
7590	Hermit Thrush	Catharus	guttatus	SHORT DISTANCE
7610	American Robin	Turdus	migratorius	SHORT DISTANCE
7660	Eastern Bluebird	Sialia	sialis	SHORT DISTANCE
EXOTIC	Rock Dove	Columba	livia	SHORT DISTANCE
GAME	Gambel's Quail	Callipepla	gambelii	SHORT DISTANCE
GAME	Ring-necked Pheasant	Phasianus	colchicus	SHORT DISTANCE
GAME	Wild Turkey	Meleagris	gallopavo	RESIDENT

Study Plan – 15 November 2002

Effects of Wildfire on the Flora and Fauna of Rio Grande Riparian Forests

Submitted in Partial Fulfillment of the Joint Venture No.

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Summary - The diverse flora and fauna of the Middle Rio Grande Valley has historically been maintained by frequent flooding. Since the 1940's, substantial flooding has not occurred within the valley. In the absence of floods, woody fuels have accumulated in the riparian forests. Consequently, the frequency of wildfires that top-kill existing native riparian vegetation has probably increased in recent decades. There is concern that these fires result in the conversion from native plants, primarily Rio Grande cottonwood (*Populus deltoids* var *wislizenii*), Gooding's willow (*Salix gooddingii*) coyote willow (*Salix exigua*) to exotic species; primarily saltcedar (*Tamarix rammosissima*) and Russian olive (*Eleagnus angustifolia*). The role of fire in the conversion from native to exotic dominated riparian vegetation has been poorly documented. This study will examine the post-wildfire floral and faunal dynamics of sites that were dominated by overstory cottonwood prior to burning. The flora and fauna of these sites will be compared to unburned neighboring sites. The ultimate goal of the project is to contribute to better management practices for restoring or rehabilitating the native flora and fauna of riparian forests burned in wildfires.

INTRODUCTION

Biodiversity of Southwestern Riparian Zones -- Riparian zones in the arid southwest support a spectacular diversity of plants and animals (Cartron et al. 2000) and are hotspots for the biodiversity of birds in North America (Dobson et al. 1997, Flather et al. 1999, Reid 1998). By Hubbard's (1977) tally, 80 % of all vertebrates in Arizona require riparian zones at some stage of their life cycle. Similarly Knopf (1985) estimated that 82% of all birds in Northern Colorado occur in the riparian zone of the North Platte. Roughly 50% of birds in lowland riparian zones of the southwest are dependent on these habitats (Johnson 1998). Hubbard (1971) further suggested that just shy of 50% of the avifauna of the San Juan and Gila River Valleys would be lost if their riparian vegetation was destroyed. By several accounts, these riparian zones support the highest densities of breeding birds in North America (Carothers et al. 1974, Stamp 1978, Stoleson and Finch 1999).

These areas also support high densities of migrating songbirds (Wauer 1977, Kelly et al. 2000, Skagen et al. 1998). Skagen et al. (1998) found densities of Wilson's and Yellow Warblers (*Dendroica petechia*) that exceeded 40 birds per ha during peak migration. These densities are probably related to the availability of arthropods in the riparian zone. Kelly et al. (2002) found that in coyote willow vegetation the number of Wilson's Warbler (*Wilsonia pusilla*) mist-netted on a given day was positively related to the number of arthropods captured. Based primarily on the diversity and abundance of birds in these systems, numerous authors have agreed that conservation of southwestern riparian habitats is a high priority (e.g., Carothers et al 1974, Cartron 2000).

Middle Rio Grande Valley – The Middle Rio Grande Valley is a 260 km reach of river in central New Mexico that extends from the outflow of Cochiti Reservoir to the inflow of Elephant Butte Reservoir (Figure 1). It drains an area of approximately 64,000 sq kms and annual discharge usually is between 500,000 and 2,500,000 acre-feet of water. Albuquerque is the largest city in the valley and 38 % of the residents of New Mexico live in the middle reach of the Rio Grande. The primary use of water from the Rio Grande is irrigation of alfalfa from April through September. The river supports riparian vegetation; which is contained within the levee for through most of the middle valley.

The dominant native woody riparian vegetation is comprised of Rio Grande Cottonwood, Coyote Willow, Black (or Goodding's) Willow, Seep Willow, New Mexico Olive, Wolf Berry, Golden Currant. The primary exotic woody plants are Saltcedar, Russian olive, and tree of heaven (*Ailanthus altissima*). While there are some areas dominated by native grasses and sedges the majority of the graminoid and herbaceous plants are weedy disturbance adapted species with broad ranges.

As is true of other major riparian zones in the Southwest, the middle reach of the Rio Grande supports a diverse flora and fauna. In a survey of the major vegetation structure types of the middle Rio Grande, Hink and Omhart (1984) documented 12 species of reptiles and amphibians, 16 species of small terrestrial mammals, and 44 species of breeding birds. Wang and Finch (2002) report 197 species of migrants detected during spring and fall migration. Among this diversity are a number of species of concern that include, silvery minnows (*Hybognathus amarus*), Southwestern Willow flycatchers (*Empidonax traillii extimus*) and Yellow-billed Cuckoos (*Coccyzus americanus*) all of which are federally protected as endangered or candidate species.

While water's role in supporting the lush vegetation of The Rio Grande's riparian zone is obvious, its critical role as the primary agent of disturbance that structures wildlife habitats in this system is less obvious. Through the physical disturbance of flooding water has historically had a central role in structuring the vegetation in the Rio Grande's riparian zone (Molles et al. 1998, Sher et al. 2000, Shafroth et al. 2001). Snowmelt typically produced a large pulse of runoff that caused spring flooding in the middle reach of the Rio Grand Valley. These floods were a nearly annual occurrence, though their magnitude differed substantially in extent among years. This flooding created and maintained a mosaic of habitat types from perennial wetlands, oxbow lakes, marsh lands, grasslands, early successional cottonwood willow communities and in isolated areas mature cottonwood forests (or Bosque; Crawford et al 1993). These floods were a critical component in the life history of disturbance adapted native plants, cottonwood and willow, that were historically dominated species in the riparian zone.

Because flooding is disruptive to many human endeavors, an enormous effort has been made since the late 1920's to regulate the flow of the Rio Grande. Consequently, there has not been a substantial flood in the Rio Grande Valley since the early 1940's. In

the late 1920's the Middle Rio Grande conservancy district was formed as a political subdivision of the New Mexico State Government with the charge of delivering water from the Rio Grande to farmers for irrigation. This delivery was made possible by an elaborate series of diversions canals and channels constructed by the State, the US Bureau of Reclamation and the US Army Corps of Engineers. The river regulation apparatus was essentially completed with the closure of Cochiti Reservoir in 1975. Regulation of the river involved the construction of levees on either side of the river, channelization of the riverbanks and stabilization of those banks with physical barriers (Jetty Jacks). As a consequence of this construction, the riparian vegetation is now limited to narrow bands (< 200m) between the channel and the levee on either side of the river.

Flood control measures have affected more than simply the distribution of riparian vegetation. Flood control removes the major regenerative disturbance that created and maintained the diverse mosaic of habitats that were central to the functioning of the Middle Rio Grande riparian zone (Molles et al. 1998, Taylor et al. 1999). The resulting effects are in some ways similar to those documented in upland forests where fire suppression has been a primary management strategy. In particular, there has been an accumulation of woody fuels that would be atypical in areas that flood regularly. This fuel accumulates because (1) rates of decomposition are lower when fuels remain dry; (2) cottonwood trees established during the 1940's floods are now senescent and dropping large amount of woody debris (Howe and Knopf 1991) and (3) in the absence of flooding, exotic shrubs established and now dominate the mid-story vegetation. Consequently, many of the ecological problems in the Rio Grande forests, including the prevalence of fire, are due to flood suppression.

Combined, the invasion of exotic plants and the accumulation of deadwood have created conditions that promote intense wildfires in the riparian zone. These wildfires typically top-kill all the existing vegetation. These fires have been blamed with converting areas dominated by native plants to exotic shrublands. Busch (1995) showed that in the Colorado River floodplain, the total acreages of burns was positively correlated with the amount of saltcedar burned. Also, in the wake of wildfires, areas that had been dominated by cottonwood and Goodding's willow, and mesquite were

converted to saltcedar (Busch 1995). While there has not been a general increase in the frequency of wildfires along the Rio Grande (Stuever 1997), there has been an ongoing conversion of native riparian vegetation to exotic dominated vegetation (Crawford et al 1993). To date there is no good experimental or descriptive studies that document the conversion from native to exotic plants directly as a result of wildfire. It is clear that the dominant natives (cottonwood and willow) sprout from roots after fires. However, there is some evidence that the long-term viability of these sprouts is poor. Stuever (1997) found that only 19% of cottonwoods killed by fire in the Rio Grande Valley had viable sprouts after a 2 growing seasons. If these numbers truly indicate an 80% reduction in the number of cottonwoods after wildfire, then the fire needs to be treated as a serious threat to remnant stands of native vegetation.

The ability of root sprouts to survive and grow after wildfire is likely linked to site conditions. Among the conditions most likely to impact the establishment of native plants are the depth to groundwater and the existing exotic vegetation on the site. This study will address three questions that are central to the role of wildfire in the Rio Grande Bosque. First, how do native plants respond to wildfires when competing with established exotic shrubs and how do the site conditions influence this balance between natives and exotics? Second, how do restoration and rehabilitation efforts on wildfire sites impact the establishment and growth of these natives? Third what impacts does post-wildfire regeneration of exotics have on the fauna inhabiting sites.

STUDY SITES

Research will be conducted on 10 wildfire sites that range in size from 100ha down to 2 ha (Table 1). Neighboring sites that had similar pre-wildfire vegetation (determined through aerial photography) will be also be monitored in a paired fashion. All but one of the wildfire sites was dominated by cottonwood overstory prior to the burning. The site without a cottonwood overstory (Bernalillo) was dominated by relatively large stature saltcedar (> 5 m in height). The Middle Rio Grande Conservancy District owns the majority of sites (8 of 10). Three of these sites are within the Rio Grande Valley State Park and therefore are co-managed by the city of Albuquerque. Bosque Del Apache National Wildlife Refuge manages the remaining two sites. Nine of

the sites are between the levee and the river channel; the exception is South 6, which is west of the low-flow conveyance channel. These 10 sites were the products of 6 different burns. The most recent burns occurred in the growing season of 2002 while the oldest burn occurred in June 1996. Rocky Mountain Research Station monitored vegetation and bird communities on 4 of the burn sites over the past 2 years. At Middle 4 data were collected for two years prior to the burn and for the initial post-burn growing season (2002). These data will be used for comparison with the data collected for this study.

METHODS

Site Locations and General Vegetation Descriptions - Site boundaries will be digitized as polygons with handheld GPS units. Depth to groundwater will be measured with 2 wells at each site. In addition to the sites listed here, new sites that burn in 2003 will be visited and assessed for inclusion in the study.

Existing vegetation on each site will be characterized with 10 ha circular plots (0.04ha) placed randomly within the site. Within these circular plots all woody plants will be tallied and have their DBH measured to the nearest centimeter. Each plant will be categorized as surviving the fire, root sprouting after the fire, or killed by fire. If the site is to be restored or rehabilitated by the landowner then the management action will be documented by quantifying the vegetation in circular plots both prior to and after the treatment. Removal of dead trees will be noted, as will plantings. Ten cottonwoods, saltcedars, Russian olives and Siberian elms (if present) will be cored at each site to determine tree ages.

Table 1. Sites that will be monitored in the proposed wildfire study plan				
Site Name	Fire Name	Burn Date	Estimated Size	Landowner
Bernalillo	Bernalillo	13 June 2001	7 ha	MRGCD
La Orrilla	La Orilla	30 April 2002	30 ha	MRGCD/COA
Atrisco	Atrisco	17 June 2001	6 ha	MRGCD/COA
Rio Bravo	RioBravo	8 May 2002	2 ha	MRGCD/COA
Bosque Farms	Inside	15 June 2000	6 ha	MRGCD

Middle 6	Rio Grande Complex	18 April 2000	20 ha	MRGCD
Middle 4	Chaves	1 April 2002	50 ha	MRGCD
Abeytas	Chaves	1 April 2002	100 ha	MRGCD
South 5	San Pedro	June 1996	20 ha	BDA-USFWS
South 6	San Pedro	June 1996	5 ha	BDA-USFWS

Cottonwood Survival - All remaining cottonwood trees within wildfire sites will be measured for DBH and status (live/partial live/dead) and will be individually tagged . The degree of fire scarring on the trunk will be categorized according to the height of the scars and the degree to which they encircle the base of the trunk. Methodology will follow that of Stuever (1997). In particular, fire severity will be categorized with the criteria of Stuever (1997); light, moderate, and high fire severity. These categories are based primarily on the condition of the remaining leaf litter. If the leaf litter is largely intact the fire is described as light. If the leaf litter is completely consumed in some areas, but unburned in other then the fire is categorized as moderate. Where nearly all of the leaves have been burned the fire is described as severe. Tree condition will include an assessment of the trees status prior to the burn if it can be assigned. Fire effects will include extent of burning at the root collar, extent and height of charring on the trunk and condition (green/scorched) of the canopy. Survival of live trees and decay of dead trees will be tracked annually. These measures will be more suitable and easier to assess for recent burns than for older burns. When cottonwood trees die core samples will be taken to determine tree age and to determine any look for any previous fire history.

Root Sprout Survival - Within each plot 20 randomly selected cottonwood, willow, saltcedar, and Russian olive root sprouts will be individually tagged and a stake will be placed 0.5m north of each sprout. The locations of all root sprouts will be GPSed. For each sprout the distance to parental stump, depth to the sprouting root, diameter of the spout at ground level, number of other sprouts within 3 meter and the number within the distance to the parental stump will be quantified. The size of these sprouts will be measured in June, July, and August 2003.

Arthropod Sampling - Within each site arthropod sampling using pitfall traps and sweep nets will be conducted in June July and August. Pitfall traps will be placed with associated vegetation type. 5 traps will be placed within 3 meters of the trunk of cottonwood, willow, Russian olive, and saltcedar. Consequently, each site will be samples with 20 pitfall traps made of 16 oz. Plastic cups with buried in the ground and a second cup placed within the buried cup so that it can be removed. Pitfall traps will be left open for 24 hour sampling periods and then closed by placing a weighted piece of plywood over them. Sweep netting will be done opportunistically to capture taxa of arthropods not well sampled by pitfall traps. All arthropods will be stored in alcohol in the field and returned to the University of Oklahoma for sorting.

Avian Community Sampling - Point count stations will be placed on sites at a spacing of 150m. Birds will be counted in June July and August 2003 and 2004. A single observer will stand at each point and count all birds heard and seen within 8 minute time periods. These counts will be done after sunrise and before 10:00am. The distance to each detection will be estimated to the nearest meter. All species will be identified by 4 letter codes (see appendix). Sites will be intensively nest searched to identify find as many breeding birds as possible. Nests will be marked and GPSed so that they can be relocated. Every third day nests will be observed to determine fate. When it is feasible and unlikely to disrupt nesting, the contents of nests will be viewed with a mirror to determine numbers of eggs and nestlings. Behavioral observations will be made of on foraging birds to determine prey selected and foraging methods used. These data will be used to understand the interactions of vegetation structure and arthropod distribution on the distribution of songbirds.

PRODUCTS

A final report will be produced by 30 May 2004. The data collected will be incorporated into The Thesis of one of more graduate students from the Department of Zoology at the University of Oklahoma. The data will also be published in peer-reviewed manuscripts that document the effects of wildfire on the vegetation, arthropods and birds of Rio Grande riparian vegetation.

Literature Cited

- Carothers, S.W., R.R. Johnson, and S.W. Atchison. 1974. Population structure and social organization of southwestern riparian birds. *Am. Zool.* 14:97-108.
- Cartron, J-L, E., S.H. Stoleson, P.L. Stoleson, and D. W. Shaw. 2000. Riparian Areas. P 281-328. in (R. Jemison and C. Raish, eds.) *Livestock Management in the American Southwest*. Elsevier. New York.
- Crawford, C. S., A.C. Cully, R. Leutheuser, M.S. Sifuentes, L.H. White, and J.P. Wilber. 1993. *Bosque Biological Management Plan*. US Fish and Wildlife Service Albuquerque, NM.
- Dobson, A.P. et al. 1997. Geographic distribution of endangered species in the united states. *Science*. 275: 550-553.
- Flather, C.H., L.A. Joyce, C.A. Bloomgarden. 1999. Species endangerment patterns in the United States. Rocky Mountain research Station technical Report RM-241. USDA Forest Service, Ft. Collins, CO.
- Hink, V.C. and R. D. Ohmart. 1984. Middle Rio Grande Biological Survey. Report submittd to US Army Corps of Engineers in fulfillment of contract No. DACW47-81-C-0015.
- Howe, W.H. and F.L. Knopf. 1991. On the imminent decline of Rio Grande cottowoods in central New Mexico. *Southwestern Naturalist*. 36: 218-224.
- Hubbard, J.P. Importance of riparian ecosystems: biotic considerantions P 14-18 in (R.R..Johnson and D.A. Jones eds.). *Importance, Preservation and Management of riparian habitat: a symposium*. USDA Forest Service Gen Tech Report RM-43. Rocky Mountain Forest and Range Experiment Station, Ft. Collins Co
- Kelly, J.F., D.M. Finch, and W Yong 2000. Vegetative associations of wood warblers migrating along the middle Rio Grande Valley, New Mexico. 45:159-168.
- Kelly, J.F. L.S. Delay, and D.M. Finch. 2002. Density dependent mass gain by Wilson's Warblers during stopover. 119: 210-213.
- Knopf, F.L. 1985. Significance of riparian vegetation to breeding birds across an altitudinal cline. P 105-111. in

- Molles, M.C. C.S. Crawford, L.M. Ellis, H.M. Valett, C.N. Dahm. 1998. Managed flooding for riparian ecosystem restoration. *Bioscience* 48:749-756.
- Reid, W.V. Biodiversity Hotspots. *Trends in ecology and Evolution* 13: 275-279.
- Shafroth, P.B. J.C. Stromberg, D.T. Patten. 2002. Riparian Vegetation Response to altered disturbance and stress regimes. *Ecological Applications* 12:107-123.
- Sher, A. A., D.L. Marshall, and S.A. Gilbert. 2000. Competition between native *Populus deltoids* and invasive *Tamarix ramosissima* and the implications for reestablishing flooding disturbance. *Conservation Biology* 14:1744-1754
- Skagen, S.K. C.P. Melcher, W.H. Howe, and F.L. Knopf. 1998. Comparative use of riparian corridors and oases by migrating birds in southeast Arizona. *Conservation Biology* 12: 896-909.
- Stamp, N.E. 1978. Breeding birds of riparian woodland in South-central Arizona. *Condor* 80: 64-71.
- Stuever, M.C., C.S. Crawford, M.C. Molles, C.S. White, and E. Muldavin. 1995. initial assessment of the role of fire in the middle Rio Grande Bosque. Pages 275-283 in *Fire effects on rare and endangered species and habitats* (J. Greenlee, ed.). International Association of Wildland Fire. Coeur d'Alene, Idaho.
- Stuever, M.C. 1997. Fire Induced mortality of Rio Grande Cottonwood. M.S. thesis. Department of Biology, University of New Mexico, Albuquerque.
- Taylor, J.P., D.B. Wester, and L.M. Smith. 1999. Soil disturbance, flood management, and riparian woody plant establishment in the Rio Grande floodplain. *Wetlands* 19:372-382.
- Wang, Y. and D.M. Finch. 2002. Consistency of mistnetting and point counts in assessing landbird species richness and relative abundance during migration. *Condor* 104: 59-73.
- Wauer, R.H. 1977. Significance of Rio Gande riparian systems upon the avifauna. P In (R.R. Johnson and D.A. Jones eds.). *Importance, Preservation and Management of riparian habitat: a symposium*. USDA Forest Service Gen Tech Report RM-43. Rocky Mountain Forest and Range Experiment Station, Ft. Collins Co.

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JOINT VENTURE AGREEMENT
(SPONSORED RESEARCH AGREEMENT)
BETWEEN THE
USDA FOREST SERVICE
ROCKY MOUNTAIN RESEARCH STATION
RESEARCH WORK UNIT NUMBER 4351
AND
THE BOARD OF REGENTS OF THE UNIVERSITY OF OKLAHOMA
BY AND ON BEHALF OF THE OKLAHOMA BIOLOGICAL SURVEY

This JOINT VENTURE AGREEMENT (SPONSORED RESEARCH AGREEMENT) is hereby made and entered into by and between the USDA Forest Service Rocky Mountain Research Station, hereinafter referred to as the Forest Service, and the Board of Regents of the University of Oklahoma, by and on behalf of the Oklahoma Biological Survey, hereinafter referred to as the The University, under the provisions of the National Agricultural Research, Extension and Teaching Policy Act of 1977 (Pub. L. 95-113), as amended by the Food Security Act of 1985 (7 U.S.C. 3318 and 3319, Pub. L. 99-198).

TITLE: Effects of Wildfire on Floral and Faunal communities of the Rio Grande Bosque

A. PURPOSE:

1. The Rio Grande and its riparian gallery forest, or bosque, is an important natural and cultural resource for the Southwestern U.S. Wildfire is the most imminent threat to the mature cottonwood vegetation of the bosque. Fuel loads in some reaches of this forest exceed 100 tons per acre. These fuels loads have lead to repeated catastrophic wildfires such as those at the Bosque del Apache National Wildlife Refuge (1996), Isleta Pueblo (2000), Los Chaves (2001). It is believed that these fires convert native dominated bosque to vegetation types dominated by exotic shrubs; Russian olive and saltcedar. In the wake of these fires there is often a desire to restore the bosque primarily through planting cottonwood and willow. From a faunal perspective, the hope is that establishing native plant communities will lead to restoration of faunal communities. To date, however, few aspects of the post-fire regenerative abilities of cottonwood, willow, Russian olive have been assessed quantitatively. Moreover the effectiveness of restoration treatments for establishing native flora and fauna to the bosque have not been addressed in a comprehensive way. This establishment is of particular concern when the species impacted are rare, threatened, or endangered (e.g., Willow Flycatchers and Yellow-billed Cuckoos). The purpose of this agreement is to improve our quantitative understanding of the effects of wildfire on bosque flora and fauna. This information will be useful in designing and implementing management plans that promote the establishment of native plants and vegetation structure that will support diverse faunal communities.
2. Open-End: This research is anticipated to be over a 3-year period with 2 phases. Future phases will be determined pending anticipated continued funding. Should this research be

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approved beyond Phase One, an amendment to this agreement shall be prepared for each new phase.

B. STATEMENT OF MUTUAL INTERESTS AND BENEFITS:

1. The Forest Service is responsible for ongoing research regarding many areas of forest research and management including wildfire and restoration in riparian zones. The Forest Service and other natural resource agencies have invested large sums of money (\$500,000+) used by management agencies (e.g., Middle Rio Grande Conservancy District) and tribal entities, in part, to restore the bosque after wildfire. The Forest Service's interest in this agreement is to better quantify wildfire restoration and its effects on floral and fauna.
2. The University's interest in this agreement is to understand the ecological effects of fire on native and exotic flora and fauna in riparian forests.
3. The Forest Service's and the University's mutual benefit and interest is to apply the best science toward managing riparian forests. This research will be a collaborative effort with the Middle Rio Grande Conservancy District, City of Albuquerque Open Space Division, Bosque Del Apache National Wildlife Refuge.

C. THE FOREST SERVICE SHALL:

1. Assist the University in the preparation of a mutually acceptable work plan.
2. Provide guidance, advice, consultation, and co-leadership essential to the satisfactory accomplishment of this agreement.
3. Collect bird population and nest data at fire study sites using standardized approach defined in fuels removal study and share findings with the University.
3. Provide statistical support and manuscript review as needed.
4. Share data and co-author publications when appropriate.
5. Supply equipment and workspace as available.
6. Train students and technical staff when appropriate and as time permits
7. Provide authorization to drive or ride in federal government vehicles when appropriate.
8. Establish consultations with the University and stakeholders such as: Middle Rio Grande Conservancy District, City of Albuquerque, and US Fish and Wildlife Service.
9. The Forest Service Technical Representative shall verify that when federally owned, leased or rented motor vehicles are to be used, that the driver 1) has completed a defensive driving course within the last 3 years, 2) has a current and valid driver's license, and 3) has received

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and read a copy of the Driver Operator Guide (EM-7130-2), a copy of which has been provided with this agreement.

D. THE UNIVERSITY SHALL:

1. Perform the following tasks for Phase One (date last signed through May 30, 2004):
 - a. Identify priority research foci that will address significant stakeholder needs.
 - b. Identify and establish study plots.
 - c. Develop data collection protocols for monitoring vegetative change, arthropod community structure, avian foraging behavior, nest monitoring, and nest predation.
 - d. Collect data on vegetation composition, vegetative change, arthropod community structure, avian foraging behavior, nest monitoring, and nest predation.
 - e. Participate in consultations with the Universitys and stakeholders such as: Middle Rio Grande Conservancy District, City of Albuquerque, and US Fish and Wildlife Service.
 - f. Share data and co-author publications as appropriate.
 - g. File copies of data at the RMRS Albuquerque lab.
2. Assist with the Forest Service in the preparation of a mutually acceptable, detailed work plan, submit a copy of the plan to the Forest Service by October 15, 2002, and conduct this study in compliance with the work plan as well as the provisions of this agreement.
3. Reports are due by dates listed below for each phase, that compare actual performance to goals, state reasons why established goals have not been met, if appropriate, and give any other pertinent information regarding the status of work. Each final phase-end report should contain the same information required in progress reports and should make recommendation regarding further research. The final report for each phase should be in a format suitable for possible publication.
 - a. Phase One Reports: Provide an Interim Progress Report by October 1, 2003, and a Final Report of Phase One by end date of Phase One.
4. Include the following credit line, along with any other appropriate credit line(s) on all reports, publications and audiovisuals, resulting from this study:

“This research was supported in part by funds provided by the Rocky Mountain Research Station, Forest Service, U.S. Department of Agriculture.”

E. IT IS MUTUALLY AGREED AND UNDERSTOOD BY ALL PARTIES THAT:

1. INTERNATIONAL AIR TRANSPORTATION FAIR COMPETITIVE PRACTICES ACT. The recipient/University organization shall comply with section 5 of the International Air Transportation Fair Competitive Practices Act of 1974, 49 U.S.C. 1517 (Fly American Act), which requires:

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- a. Any air transportation to, from, between, or within a country, other than the U.S., of persons or property, the expense of which will be assisted by USDA funding, will be performed on a United States flag carrier if service provided by such carrier is "available."
- b. For the purposes of the requirement:
 1. Passenger or freight service by a certified air carrier is considered "available" even though:
 - a. Comparable or a different kind of service by a non-certificated air carrier costs less; or
 - b. Service by a non-certificated air carrier can be paid for in excess foreign currency; or
 - c. Service by a non-certificated air carrier is preferred by the recipient organization contractor or traveler needing air transportation.
 2. Passenger service by a certificated air carrier is considered to be "unavailable":
 - a. When the traveler, while enroute, has to wait 6 hours or more for an available U.S. carrier; or
 - b. When any flight by a U.S. carrier interrupted by a stop anticipated to be 6 hours or more for refueling, reloading, repairs, and so forth, and no other flight by a U.S. carrier is available during the 6 hour period; or
 - c. When the flight by a U.S. carrier takes 12 or more hours longer than a foreign carrier.
2. FOREST SERVICE ACKNOWLEDGED IN PUBLICATIONS AND AUDIOVISUALS. Forest Service support shall be acknowledged in any publications and audiovisuals developed as a result of this instrument.
3. FEDERAL COST PRINCIPLES. This agreement will be governed by OMB Circular No. A-21, Cost Principles for Educational Institutions and audit requirements under OMB Circular A-133, Audits of States, Local Governments and Non-profit Organizations.
4. COLLECTION OF AMOUNTS DUE THE FEDERAL GOVERNMENT. Pursuant to 31 U.S.C. 3716 and 7 CFR, Part 3, Subpart B, any funds paid to the University in excess of the amount to which the University is finally determined to be entitled under the terms and conditions of the award constitute a debt to the Federal Government. If not paid within a reasonable period after the demand for payment, the Federal awarding agency may reduce the debt by:
 1. Making an administrative offset against other requests for reimbursements.
 2. Withholding advance payments otherwise due to the University.

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3. Taking other action permitted by statute.

Except as otherwise provided by law, the Federal awarding agency shall charge interest on an overdue debt in accordance with 4 CFR, Chapter II "Federal Claims Collection Standards" and 31 U.S.C., Chapter 37.

5. TAXPAYER IDENTIFICATION NUMBER. The University shall furnish their tax identification number upon execution of this instrument.
6. RIGHT TO TRANSFER EQUIPMENT AND SUPPLIES. Equipment and supplies approved for purchase under this instrument are available only for use as authorized. The Forest Service reserves the right to transfer title to the Federal government of equipment and supplies, valued over \$5,000 per unit, purchased by the University using any Federal funding. Upon expiration of this instrument the University shall forward an equipment and supply inventory to the Forest Service, listing all equipment purchased throughout the life of the project and unused supplies. Disposition instructions will be issued by the Forest Service within 120 calendar days.
7. FREEDOM OF INFORMATION ACT (FOIA). Any information furnished to the Forest Service under this instrument is subject to the Freedom of Information Act (5 U.S.C. 552).
8. RETENTION AND ACCESS REQUIREMENTS FOR RECORDS. The Forest Service, Inspector General, or Comptroller General, through any authorized representative, shall have access to and the right to examine all records related to this instrument.

As used in this provision, "records" includes books, documents, accounting procedures and practices, and other data, regardless of type and regardless of whether such items are in written form, in the form of computer data, or in any other form. All records pertinent to the award shall be retained for a period of 3 years.

9. MODIFICATION. Modifications within the scope of the instrument shall be made by mutual consent of the parties, by the issuance of a written modification, signed and dated by all parties, prior to any changes being performed. The Forest Service is not obligated to fund any changes not properly approved in advance.
10. NONDISCRIMINATION. The University shall comply with all Federal statutes relating to nondiscrimination and all applicable requirements of all other Federal laws, Executive orders, regulations, and policies. These include but are not limited to: (a) Title VI of the Civil Rights Act of 1964 (42 U.S.C. 2000d, 2000e-16), which prohibits discrimination on the basis of race, color, disability, or national origin; (b) Title IX of the Education amendments of 1972, as amended (20 U.S.C. 1681-1683, and 1685-1686), which prohibits discrimination on the basis of sex; and Section 504 of the Rehabilitation Act of 1973 as amended (29 U.S.C. 794) which prohibits discrimination on the basis of disabilities. The nondiscrimination statement which follows shall be posted in primary and secondary recipient/University offices, at the public service delivery contact point and included, in full, on all materials regarding such recipients'/University's programs that are produced by the recipients'/University for public information, public education, or public distribution:

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"In accordance with Federal law and U.S. Department of Agriculture policy, this institution is prohibited from discriminating on the basis of race, color, national origin, sex, age, or disability. (Not all prohibited bases apply to all programs.)

To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, Room 326-W, Whitten Building, 1400 Independence Avenue, SW, Washington, DC 20250-9410 or call (202) 720-5964 (voice and TDD). USDA is an equal opportunity provider and employer."

If the material is too small to permit the full statement to be included, the material will at minimum include the statement, in print size no smaller than the text, that "This institution is an equal opportunity provider."

11. ENVIRONMENTAL STANDARDS. The University will comply with environmental standards pursuant to the notification of violating facilities in E.O. 11738.
12. LEGAL AUTHORITY. The University has the legal authority to enter into this instrument, and the institutional, managerial and financial capability (including funds sufficient to pay nonfederal share of project costs) to ensure proper planning, management, and completion of the project.
13. PARTICIPATION IN SIMILAR ACTIVITIES. This instrument in no way restricts the Forest Service or the The University(s) from participating in similar activities with other public or private agencies, organizations, and individuals.
14. COMMENCEMENT/EXPIRATION DATE. This instrument is executed as of the date of last signature and is effective through May 30, 2004 at which time it will expire unless extended.
15. EXTENSION OF PERFORMANCE PERIOD. The Forest Service, by written modification may extend the performance period of this instrument for a total duration not to exceed 5 years from its original date of execution.
16. TERMINATION. Any of the parties, in writing, may terminate the instrument in whole, or in part, at any time before the date of expiration. No parties shall incur any new obligations for the terminated portion of the instrument after the effective date and shall cancel as many obligations as possible. Full credit shall be allowed for each Party's expenses and all non-cancelable obligations properly incurred up to the effective date of termination.
17. PRINCIPAL CONTACTS. The principal contacts for this instrument are:
 - a. FOREST SERVICE TECHNICAL REPRESENTATIVE(S):

FS Technical Representative:	Deborah Finch
Forest Service Organization:	USDA FS, Rocky Mountain Research Station
Street Address:	333 Broadway SE, Suite 115
City, State & Zip:	Albuquerque, NM 87102
Telephone:	505-724-3671
Fax:	505-724-3688
Email:	dfinch@fs.fed.us

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b. FOREST SERVICE ADMINISTRATIVE CONTACT:

Forest Service Contact:	Carolyn Lumar
Forest Service Organization:	USDA FS, Rocky Mountain Research Station
Street Address:	240 West Prospect Road
City, State & Zip:	Fort Collins, CO 80526-2098
Telephone:	(970) 498-1172
Fax:	(970) 498-1396
Email:	clumar@fs.fed.us

c. THE UNIVERSITY'S TECHNICAL REPRESENTATIVE(S):

Principal Investigator:	Jeffrey F. Kelly
Department/Unit:	Oklahoma Biological Survey and Dept of Zoology (After 1 July 2002)
The University Name:	University of Oklahoma
Street Address/PO Box:	111 East Chesapeake St.
City, State & Zip:	Norman, OK 73019
Telephone:	405 - 325 - 1985
Fax:	
Email:	

d. THE UNIVERSITY'S ADMINISTRATIVE CONTACT:

Name, Title:	Alyson M. McCarty, Proposal Services Specialist
Department/Unit:	Proposal Services
The University Name:	University of Oklahoma
Street Address/PO Box:	214 Robertson Hall, 731 Elm Avenue
City, State & Zip:	Norman, OK 73019
Telephone:	(405)325-3901
Fax:	(405)325-7750
Email:	amccarty@ou.edu

18. AVAILABILITY OF FUNDS. Funds in the amount of \$35,000 are currently obligated for performance of this instrument through May 30, 2004. The Forest Service's obligation for performance of this instrument beyond this date is contingent upon the availability of appropriated funds from which payment can be made. No legal liability on the part of the Forest Service for any payment may arise for performance under this instrument beyond May 30, 2004, until funds are made available to the Forest Service for performance and until the grantee/University receives notice of availability to be confirmed in a written modification by the Forest Service.
19. COPYRIGHTING. The University is granted sole and exclusive right to copyright resultant publications, including the right to publish and vend throughout the world in any language and in all media and forms, in whole or in part, for the full term of copyright and all renewals thereof in accordance with this instrument. However, the University shall not sell, or grant

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copyrights to a third-party designee who intends to sell, the document as a profit-making venture. No original text or graphics produced and submitted by the Forest Service shall be copyrighted. The Forest Service reserves a royalty-free, nonexclusive, and irrevocable right to reproduce, publish, or otherwise use, and to authorize others to use, the work for Federal government purposes. This right shall be transferred to any sub-agreements or subcontracts. This provision includes:

- a. The copyright in any work developed by the University under this instrument.
- b. Any rights of copyright to which the University purchases ownership with any Federal contributions.

20. PUBLICATION. Neither party will publish any results without consulting the other. This is not to be construed as applying to popular publication of previously published technical matter. Publication may be joint or independent as agreed upon, always giving due credit to the cooperation and recognizing the individuals doing the work. In the case of failure to agree as to the manner of publication or interpretation of results, either party may publish after due notice and submission of the proposed manuscript to the other. In such instances, the party publishing the data will give credit to the cooperation, but assume full responsibility for any statements on which there is a difference of opinion.

21. ELECTRONIC FUNDS TRANSFER. The University shall designate a financial institution or an authorized payment agent through which a Federal payment may be made in accordance with U ar.S. Treasury Regulations, Money and Finance at 31 CFR 208, which requires that Federal payments e to be made by electronic funds transfer (EFT) to the maximum extent possible. A waiver may be requested and payment received by check by certifying in writing that one of the following situations apply:

1. The payment recipient does not have an account at a financial institution.
2. EFT creates a financial hardship because direct deposit will cost the payment recipient more than receiving a check.
3. The payment recipient has a physical or mental disability, or a geographic, language, or literacy barrier.

To initiate receiving your payment(s) by electronic transfer, contact the National Finance Center (NFC) on the worldwide web at www.nfc.usda.gov, or call the NFC at 1-800-421-0323, or (504) 255-4647. Upon enrollment in the program you may begin to receive payment by electronic funds transfer directly into your account.

22. PAYMENT/REIMBURSEMENT. Reimburse the University for the Forest Service's proportionate share (79.4%) of actual expenses incurred, not to exceed \$35,000, reduced by program income, and other Federal and nonfederal cash contributions, as shown in the incorporated Financial Plan. If program income generated from the project exceeds the University's actual expenses, the Forest Service share is zero. TheUniversity is approved to submit monthly billing(s). The Forest Service will make payment for its share of project costs upon receipt of an invoice or SF-270. Each invoice or SF-270 shall display the University's actual expenditures to date of the invoice or SF-270 (not just the Forest Service share of actual expenditures), displayed by separate cost elements as documented in the

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Financial Plan, less program income and other Federal and nonfederal cash contributions and previous Forest Service payments. The invoice or SF-270 should be forwarded as follows:a. Send an original and two copies to:

Grants and Agreements Staff
 USDA Forest Service
 Rocky Mountain Research Station
 240 West Prospect
 Fort Collins CO 80526-2098

23. PROGRAM PERFORMANCE REPORTS. Submit a performance report at least annually. The final performance report shall be submitted either with your final payment request, or no later than 90 days from the expiration date of the instrument.
24. PATENT RIGHTS. Each instrument awarded to a small business firm, non-profit organization, or University which is to be performed in the United States, its possessions, or Puerto Rico and has as a purpose the performance of experimental, development, or research work, shall contain the (beginning of clause) Patents Rights Clause.
 - a. Definitions:
 - (1) Invention. Any invention or discovery which is or may be patentable, or otherwise protectable under Title 35 of the United States Code (U.S.C.), or any novel variety of plant which is or may be protected under the Plant Variety Protection Act (7 U.S.C. 2321 et seq.).
 - (2) Subject Invention. Any invention of the recipient/University conceived or first actually reduced to practice in the performance of work under this instrument, provided that in the case of a variety of plant, the date of determination (as defined in section 41(d) of the Plant Variety Protection Act, 7 U.S.C. 2401(d) must also occur during the period of the instrument performance.
 - (3) Practical Application. To manufacture in the case of a composition or product, to practice in the case of a process or method, or to operate in the case of a machine or system and, in each case, under such conditions as to establish that the invention is being utilized and that its benefits are, to the extent permitted by law or Government regulations available to the public on reasonable terms.
 - (4) Made. When used in relation to any invention, the conception or first actual reduction to practice of such invention.
 - (5) Small Business Firm. A small business concern as defined at section 2 of Public Law 85-536 (15 U.S.C. 632) and implementing regulations of the administrator of the Small Business Administration. For the purpose of this clause, the size standard for small business concerns involved in Government procurement and subgranting as 13 CFR 121.3-8 and 13 CFR 121.3-12, respectively, will be used.
 - (6) Non-Profit Organization. A university or other institution of higher education or an organization of the type described in section 501 (c) (3) of the Internal Revenue Code

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of 1954 Internal Revenue Code (26 U.S.C. 501c) and exempt from taxation under section 501(a) of the Internal Revenue Code (26 U.S.C. 501(a)) or any nonprofit scientific or educational organization qualified under a State nonprofit organization statute.

- b. Allocation of Principal Rights. The recipient/University may retain the entire right, title, and interest throughout the world to each subject invention, subject to the provisions of this clause and 35 U.S.C. 203. With respect to any subject invention in which the recipient/University retains title, the Federal government shall have a nonexclusive, nontransferable, irrevocable, paid-up license to practice or have practiced for or on behalf of the United States any subject invention through out the world.
- c. Invention Disclosure, Election, of Title and Filing of Patent Applications by the Recipient/University.
 - (1) The recipient/University will disclose each subject invention to the Forest Service within two months after the inventor discloses it in writing to personnel responsible for patent matters. The disclosure to the Forest Service shall be in the form of a written report and shall identify the instrument under which the invention was made and the inventor(s). It shall be sufficiently complete in technical detail to convey a clear understanding, to the extent known at the time of the disclosure, of the nature, purpose, operation, and the physical, chemical, biological or electric characteristics of the invention. The disclosure shall also identify any publication, on sale of public use of the invention, and whether a manuscript describing the invention has been submitted for publication and, if so, whether it has been accepted for publication at the time of disclosure. In addition, after disclosure to the Forest Service, the recipient/University shall promptly notify the Forest Service of the acceptance of any manuscript describing the invention for publication or of any on sale or public use planned by the recipient/University.
 - (2) The recipient/University will elect in writing whether or not to retain title to any such invention by notifying the Forest Service within 2 years of disclosure to the recipient/University; provided that in any case where publication, on sale or public use has initiated the 1 year statutory period wherein valid patent protection can still be obtained in the United States, the period for election of title may be shortened by the Forest Service to a date that is no more than 60 days prior to the end of the statutory period.
 - (3) The recipient/University will file its initial patent application on an elected invention within 1 year after election or, if earlier, prior to the end of any statutory period wherein valid protection can be obtained in the United States after publication, on sale, or public use. The recipient/University shall file patent applications in additional countries within either 10 months from the corresponding initial patent application or 6 months from the date permission is granted by the Commissioner of Patents and trademarks to file foreign patent applications where such filing has been prohibited by a Secrecy Order.
 - (4) Requests for extension of the time for disclosure to the Forest Service, election, and filing may, at the discretion of the Forest Service, be granted.

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- d. Conditions when the Government May Obtain Title. The recipient/University shall convey to the Forest Service, upon written request, title to any subject invention:
- (1) If the recipient/University fails to disclose or elect the subject invention within the times specified in item c herein or elects not to retain title; provided that the Forest Service may only request title within 60 days after learning of the failure of the grantee or the University to disclose or elect within the specified times.
 - (2) In those countries in which the recipient/University fails to file patent applications within the times specified in item c(3) herein; provided, however, that if the recipient/University has filed a patent application in a country after the times specified in item c(3), but prior to its receipt of the written request of the Forest Service, the recipient/University shall continue to retain title in that country.
 - (3) In any country in which the recipient/University decides not to continue the prosecution of any application for, to pay the maintenance fees on, or defend in reexamination or opposition proceeding on, a patent on a subject invention.
- e. Minimum Rights to Recipient/University and Protection of the Contractor Right to File.
- (1) The recipient/University shall retain a nonexclusive, royalty-free license throughout the world in each subject invention to which the Government obtains title, except if the recipient/University fails to disclose the subject invention within the times specified in item c herein. The recipient's/University's license extends to its domestic subsidiaries and affiliates, if any, within the corporate structure of which the recipient/University is a party and includes the right to grant sublicenses of the same scope to the extent the recipient/University was legally obligated to do so at the time the instrument was awarded. The license is transferable only with approval of the Forest Service, except when transferred to the successor of that party of the recipient's/University's business to which the invention pertains.
 - (2) The recipient's/University's domestic license may be revoked or modified by the Forest Service to the extent necessary to achieve expeditious practical application of the subject invention, pursuant to an application for an exclusive license submitted in accordance with applicable provisions at 37 CFR Part 404. This license will not be revoked in that field of use or the geographical areas in which the recipient/University has achieved practical application and continues to make the benefits of the invention reasonably accessible to the public. The license in any foreign country may be revoked or modified at the discretion of the Forest Service to the extent the recipient/University, its licensees, or its domestic subsidiaries or affiliates have failed to achieve practical application in that foreign country.
 - (3) Before revocation or modification of the license the Forest Service shall furnish the recipient/University a written notice of its intention to revoke or modify the license, and the recipient/University shall be allowed 30 days (or such other time as may be authorized by the Forest Service for good cause shown by the recipient/the University) after the notice to show cause why the license should not be revoked or modified. The recipient/University has the right to appeal, in accordance with applicable regulations in 37 CFR Part 404 concerning the licensing Government-

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owned inventions, any decision concerning the revocation or modification of its license.

f. Recipient/The University Action to Protect the Government's Interest

- (1) The recipient/the University agrees to execute, or to have executed, and promptly deliver to the Forest Service all instruments necessary to (a) establish or confirm the rights the Government has throughout the world in those subject inventions to which the recipient/University elects to retain title, and (b) convey title to the Forest Service when requested under paragraph (c) herein and to enable the Government to obtain patent protection throughout the world in that subject invention.
- (2) The recipient/University agrees to require, by written instrument, its employees, other than clerical and non-technical employees, to disclose promptly in writing to personnel identified as responsible for the administration of patent matters and in a format suggested by the recipient/University each subject invention made under the disclosure provisions of paragraph c herein and to execute all papers necessary to file patent applications on subject inventions and to establish the Government's rights in the subject invention. This disclosure format should require, as a minimum, the information required by paragraph (c) above, and to execute all papers necessary to file patent applications on subject inventions and to establish the government's rights in the subject inventions. This disclosure format should require, as a minimum, the information required by paragraph (c)(1). The recipient/University shall instruct such employees' agreements or other suitable educational programs on the importance of reporting inventions in sufficient time to permit the filing of patent applications prior to United States or foreign statutory bars.
- (3) The recipient/University will notify the Forest Service of any decision not to continue the prosecution of a patent application, pay maintenance fees, or defend in a reexamination or opposition proceeding on a patent, in any country, not less than 30 days before the expiration of the response period required by the relevant patent office.
- (4) The recipient/University agrees to include, within the specification of any United States patent application and any patent issuing thereon covering a subject invention, the following statement: This invention was made with the Government support under (identify the grant or agreement) awarded by the Forest Service. The Government has certain rights in this invention.

g. Subcontracts

- (1) The recipient/University will include this clause, suitably modified to identify the parties, in all subcontracts, regardless of tier, for experimental, developmental, or research work to be performed by a small business firm or domestic nonprofit organization. The subcontractor shall retain all rights provided for the recipient/University in this clause, and the recipient/University shall not, as part of the consideration for awarding the subgrant or subcontract under the instrument, obtain rights in the subgrantee's or subcontractor's subject inventions.

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- (2) The recipient/University will include in all other subcontracts the patent rights clause, regardless of tier, for experimental, developmental, or research work (cite agency implementing regulations or FAR).
- (3) In the case of subcontracts, at any tier, when the prime award with the Federal agency was a contract (but not a grant or cooperative agreement), the agency, subcontractors, and the contractor agree that the mutual obligations of the parties created by this clause constitute a contract between the subcontractor and the Federal agency with respect to those matters covered by this clause; provided, however, that nothing in this paragraph is intended to confer any jurisdiction under the Contract Disputes Act in connection with proceedings under paragraph (j) of this clause.
- h. Reporting on Utilization of Subject Invention. The recipient/University agrees to submit, on request, periodic reports no more frequently than annually on the utilization of a subject invention or on efforts at obtaining such utilization that are being made by the recipient/University or its licensees or assignees. Such reports shall include information regarding the status of development, date of first commercial sale or use, gross royalties received by the recipient/University, and such other data and information as the Forest Service may reasonably specify. The recipient/University also agrees to provide additional reports as may be requested by the Forest Service in connection with any march-in proceeding undertaken by the Forest Service in accordance with paragraph (j) of this clause. As required by 35 U.S.C. 202(c)(5), the Forest Service agrees it will not disclose such information to persons outside the government without permission of the recipient/University.
- i. Preference for United States Industry. Notwithstanding any other provision of this clause, the recipient/University agrees that neither it nor any assignee will grant to any person the exclusive right to use or sell any subject invention in the United States unless such person agrees that any product embodying the subject invention will be manufactured substantially in the United States. However, in individual cases the requirement for such an agreement may be waived by the Forest Service upon a showing by the recipient/University or its assignee that reasonable but unsuccessful efforts have been made to grant licenses on similar terms to potential licensees that would be likely to manufacture substantially in the United States, or that under the circumstances, domestic manufacture is not commercially feasible.
- j. March-in-Rights. The recipient/University agrees that with respect to any subject invention in which it has acquired title, the Forest Service has the right in accordance with the procedures in 37 CFR 401.6 and any supplemental regulations of the Forest Service to require the recipient/University, an assignee or exclusive licensee of a subject invention to grant a nonexclusive, partially exclusive, or exclusive license in any field of use to a responsible applicant or applicants, upon terms that are reasonable under the circumstances, and if the recipient/University assignee, or exclusive licensee refuses Forest Service has the right to grant such a license itself if the Forest Service determines that:
- (1) Such action is necessary because such a request, the recipient/University or assignee has not taken, or is not expected to take within a reasonable time, effective steps to achieve practical application of the subject invention in such field of use;

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- (2) Such action is necessary to alleviate health or safety needs which are not reasonably satisfied by the recipient/University, assignee, or their licensees;
- (3) Such action is necessary to meet requirements for public use specified by Federal regulations and such requirements are not reasonably satisfied by the recipient/University, assignee, or licensees; or
- (4) Such action is necessary because the agreement required by paragraph 9 of this provision has not been obtained or waived, or because a licensee of the exclusive right to use or sell any subject invention in the United States is in breach of such agreement.

k. Special Provisions for Contracts with Non-profit Organizations. If the recipient/contractor is a non-profit organization, it agrees that:

- (1) Rights to a subject invention in the United States may not be assigned without the approval of the Forest Service, except where such assignment is made to an organization which has as one of its primary functions the management of inventions provided that such assignee will be subject to the same provisions as the recipient/University.
- (2) The recipient/University will share royalties collected on a subject invention with the inventor, including Federal employee co-inventors (when the agency deems it appropriate) when the subject invention is assigned in accordance with 35 U.S.C. 202(e) and 37 CFR 401.10.
- (3) The balance of any royalties or income earned by the recipient/University with respect to subject inventions, after payment of expense (including payments to inventor) incidental to the administration of subject inventions will be utilized for the support of scientific research or education; and
- (4) It will make efforts that are reasonable under the circumstances to attract licensees of subject invention that are small business firms and that it will give preference to a small business firm when licensing a subject invention if the recipient/University determines that the small business firm has a plan or proposal for marketing the invention which, if executed, is equally as likely to bring the invention to practical application as any plans or proposals from applicants that are not small business firms; provided, that the recipient/University is also satisfied that the small business firm has the capability and resources to carry out its plan or proposal. The decision whether to give preference in any specific case will be at the discretion of the recipient/University. However, the recipient/University agrees that the Secretary may review the recipient's/University's licensing program and decisions regarding small business applicants, and the recipient/University will negotiate changes to its licensing policies, procedures, or practices with the Secretary when the Secretary's review discloses that the recipient/University could take reasonable steps to implement more effectively the requirements of this paragraph (11)(d).

l. Communication

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- (1) The central point of contact within the U.S. Department of Agriculture for communications relating to the administration of this provision is:

Deputy Assistant General Counsel for Patents
Research and Operations Division
Office of the General Counsel
U.S. Department of Agriculture
Room 2332, South Building
Washington, D.C. 20250

- (2) Disclosure statements are made through the Authorized Departmental Office to:

National Patent Program
Patent Advisor
Forest Service, USDA
One Gifford Pinchot Drive
Madison, WI 53705-2398

- (3) Practice statements are made to the Patent Advisor.

NOTE: Exceptions for Not Using the Patent Rights Provision:

- (a) When the instrument is for the operation of a federally funded research and development center of a government-owned production facility;
- (b) In exceptional circumstances when it is determined by the Forest Service that restriction or elimination of the right to retain title to any subject invention shall better promote the policy and objective of Title 35, Chapter 18 of the United States Code; or
- (c) When it is determined by a Government authority which is authorized by statute or Executive Order to conduct foreign intelligence or counter intelligence activities that the restriction or elimination of the right to retain title to any subject invention is necessary to protect the security of such activities.

Any determination under this section shall be in writing and accompanied by a written statement of facts and shall contain such information as the Forest Service field office deems relevant and, at a minimum, shall:

- (1) Identify the small business firm or nonprofit organization involved.
- (2) Describe the extent to which Forest Service action restricted or eliminated the right to retain title to a subject invention.
- (3) State the facts and rationale supporting the Forest Service action.
- (4) Provide supporting documentation for those facts and rationale.
- (5) Indicate the nature of any objections to the Forest Service action and provide any documentation in which those objections appear. A copy of each such determination and written statement of facts shall be sent to the Director, Fiscal and Public Safety,

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Washington Office, for review and forwarded to the Comptroller General of the United States within 30 days after the award of the applicable grant or cooperative agreement. In some cases of determinations applicable to instruments with small business firms, copies shall also be sent to the Chief Counsel for advocacy of the Small Business Administration.

25. INDIRECT COSTS AND TUITION REMISSION. In accordance with Title 7, U.S.C. 3319, indirect costs and tuition remission are not reimbursable to State Cooperative Institutions under joint venture (sponsored research) and cooperative agreements. However, it should be noted that indirect costs may be used by State Cooperative Institutions to satisfy matching or cost-sharing requirements.

26. FOREST SERVICE CODE OF SCIENTIFIC ETHICS. All persons performing under this agreement will be aware of and perform according to the Forest Service Code of Scientific Ethics found at <http://www.fs.fed.us/research/sciethics>.

F. SIGNATURES:

The parties hereto have executed this joint venture (sponsored research) agreement as of the last date written below. No costs will be reimbursed or credit given for cost share or expenditures incurred before last date signed or after the completion date.

/s/ Alison Hill

Date: 07/01/02

ALISON HILL
Assistant Station Director for Research
USDA FS, Rocky Mountain Research Station

Signed On Behalf Of The Board Of Regents Of The University Of Oklahoma And On Behalf Of The Oklahoma Biological Survey

/s/ Susan Wyatt Sedwick
The University Signatory

Date: 06/25/02

Susan Wyatt Sedwick, Ph.D.
Typed Name

Executive Director, Research Services
Typed Title

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THE UNIVERSITY: Please provide the following billing information to ensure efficient payment processing.

Payee Name:	The University of Oklahoma
Payee Address:	Office of Research Services
Street Address/PO Box:	660 Parrington Oval, RM 324
City, State & Zip:	Norman, OK 73019
Telephone Number (optional):	(405) 325-4979
Tax Identification Number: (Mandatory - If this number is not provided, payments cannot be processed.)	73-6017987

= \$2,500

Forest Service Job Code: REVR54 = \$20,000 & F2RW02 = \$15,000; FREX2A02 = \$17,500



File Code: 1580

Date:

Alyson M. McCarty, Proposal Services Specialist
Proposal Services
University of Oklahoma
214 Robertson Hall, 731 Elm Avenue
Norman, OK 73019

Ref: Amendment to Forest Service Agreement Number 02-JV-11221602-185

Dear Ms. McCarty:

The Forest Service agrees to amend the referenced agreement as indicated below. If the cooperator has requested the amendment, the request letter/email, etc. is attached and incorporated into this amendment.

- ☐ A no-cost time extension from _ through _.
Explanation:
- ☒ A time extension from May 30, 2004 through December 31, 2005.
Explanation:
- ☐ Changes in the previous reporting dates.
Explanation:
- ☒ Budget changes. Please see Financial Plan.
Explanation: Additional \$35,000 in Forest Service Costs and \$12,886 from the University as Indirect Costs (27%).

Funds in the amount of \$35,000 are currently obligated for performance of this instrument through May 30, 2004. The Forest Service's obligation for performance of this instrument beyond this date is contingent upon the availability of appropriated funds from which payment can be made. No legal liability on the part of the Forest Service for any payment may arise for performance under this instrument beyond _ until funds are made available to the Forest Service for performance and until the grantee/cooperator receives notice of availability to be confirmed in a written modification by the Forest Service.

- ☐ The purchase of equipment.
Explanation:
- ☐ Change in Principal Investigator.
The Principal Investigator is changed from _ to _.
Explanation:
- ☐ Additional Tasks.
Explanation:
- ☐ Other.
Explanation:



All other provisions of the original agreement and subsequent amendments remain unchanged.

If you have any administrative questions or concerns, please call Carolyn Lumar at 970-498-1172.

OR

If you concur with the terms of this amendment letter, please acquire the appropriate signature and return one fully executed copy to the attention of Carolyn Lumar at the letterhead address. Retain the other copy for your files. If you have any administrative questions or concerns, please call Carolyn at 970-498-1172. The effective date of this amendment is the last date of signature below.

Assistant Station Director for Research
Assistant Station Director for Research

Accepted for: _____

Accepted for: _____

By: _____

Date: _____

cc:

Fiscal/Budget

Job Code = FRF202

Accepted for: _____

By: _____ Date: _____

FINANCIAL PLAN - JOINT VENTURE

FINANCIAL PLAN - JOINT VENTURE				
		Agreement Number: _____		
		Date last signed through: _____		
Cost Elements	Details	(a) FS Reimbursement to Cooperator	(b) Cooperator Noncash Contribution	(c) Totals
Direct Costs:				
Salaries				
Principal Investigator		\$0.00	\$0.00	\$0.00
Research Associates	\$1300/ month x 14 months	\$18,200.00	\$0.00	\$18,200.00
Technical Assistants	\$1000 per month x 6 months	\$6,000.00	\$0.00	\$6,000.00
Other Personnel		\$0.00	\$0.00	\$0.00
Total Salaries:		\$24,200.00	\$0.00	\$24,200.00
Fringe Benefits				
Principal Investigator		\$0.00	\$0.00	\$0.00
Research Associates	6.89 % of \$18, 200 + 5.11 % of 18,200	\$2,185.00	\$4,004.00	\$6,189.00
Technical Assistants	9.25% of \$6,000	\$555.00	\$0.00	\$555.00
Other Personnel		\$0.00	\$0.00	\$0.00
Total Fringe Benefits:		\$2,740.00	\$4,004.00	\$6,744.00
Travel				
Mileage	1500 miles per trip x 4 trips x \$0.36 per mile	\$2,160.00	\$0.00	\$2,160.00
Lodging	\$20 per night x 200 nights	\$4,000.00	\$0.00	\$4,000.00
Total Travel:		\$6,160.00	\$0.00	\$6,160.00
Equipment (nonexpendable)	video cameras	\$1,000.00	\$0.00	\$1,000.00
Supplies (expendable)	Arthropod sampling eqt. mist nets, video tapes	\$900.00	\$0.00	\$900.00
Contractual (identify)		\$0.00	\$0.00	\$0.00
Other Direct Expenses	Identify:	\$0.00	\$0.00	\$0.00
Total Direct Costs:		\$35,000.00	\$4,004.00	\$39,004.00
Indirect Costs:	See rules - Note 2	\$0.00	\$8,882.00	\$8,882.00
Gross Total Costs:		\$35,000.00	\$12,886.00	\$47,886.00
Add/Deduct Estimated Program Income			\$0.00	\$0.00
Total Project Costs:		\$35,000.00	\$12,886.00	\$47,886.00
Remarks:				
Note 1: Other Federal cash contributions cannot be considered as part of Cooperator's 20% minimum contribution. Note 2: Detail on Indirect Costs: If Cooperator is a State Cooperative Institution, no indirect costs or tuition remission may be charged against any federal funds provided under this agreement. If Cooperator is not a State Cooperative Institution, there is a 10% reimbursement limit on indirect costs (10% x direct costs = reimbursable indirect costs maximum.)				
If equipment is being purchased, please check the appropriate statement:				
Cooperator shall retain ownership of equipment when agreement terminates.		()		
Forest Service shall retain ownership of equipment when agreement terminates.		()		
Financial Plan Instructions: (for worksheet page 1.)				
(a) FS reimbursement to Cooperator: Maximum FS funding to be obligated under the agreement for reimbursement of FS share of Cooperator expenses.				
(b) Cooperator Noncash Contribution: Expenses the Cooperator incurs that are contributed to the project for their share of project costs.				
(c) Total of Columns A & B.				

	<u>Indirect Cost Detail (G&A Staff will complete):</u>			
	Type of Rate: (Please enter X in adjacent column)			
	Provisional:			
	Predetermined:			
	Final:			
	Fixed:			
	Rate (%):			
	Base (\$):			
	Total Amount (\$):			
	<u>Cooperator please check appropriate rate:</u>			
	Off-Campus Rate: []			
	On-Campus Rate: []			
	Not Applicable: Cooperator is not a University []			
	<u>Costs for Payment Purposes (G&A Staff will complete):</u>			
	<u>Contribution Determination</u>	<u>Payment Share</u>		
(1) Total FS Share = Gross Total Cost (a) /Total Project Cost (c)		<u>73.09%</u>	(Cannot be > 80%)	
(2) Total Cooperator Contribution = Total Project Cost (b)/Total Project Cost (c)		<u>26.91%</u>	(Cannot be < 20%)	
(3) Total of (1) & (2) should equal 100%		<u>100.00%</u>		
				(Revised 3/30/2001)

FINANCIAL PLAN - JOINT VENTURE

Agreement Number:

02-JV-11221602-185

Date last signed through: 05/30/04

Cost Elements	Details	(a) FS Reimbursement to Cooperator	(b) Cooperator Noncash Contribution	(c) Totals
Direct Costs:				
Salaries				
Principal Investigator		\$0.00	\$0.00	\$0.00
Research Associates	(\$1300/month X 22 Months)	\$28,600.00	\$0.00	\$28,600.00
Technical Assistants		\$0.00	\$0.00	\$0.00
Other Personnel		\$0.00	\$0.00	\$0.00
Total Salaries:		\$28,600.00	\$0.00	\$28,600.00
Fringe Benefits				
Principal Investigator		\$0.00	\$0.00	\$0.00
Research Associates	3% of Salary	\$858.00	\$0.00	\$858.00
Technical Assistants		\$0.00	\$0.00	\$0.00
Other Personnel		\$0.00	\$0.00	\$0.00
Total Fringe Benefits:		\$858.00	\$0.00	\$858.00
Travel				
Trip #1	Vehicle = \$900, Lodging = \$1000	\$1,900.00	\$0.00	\$1,900.00
Trip #2	Vehicle = \$900, Lodging = \$1000	\$1,900.00	\$0.00	\$1,900.00
Total Travel:		\$3,800.00	\$0.00	\$3,800.00
Equipment (nonexpendable)		\$0.00	\$0.00	\$0.00
Supplies (expendable)	Meter Tapes, Clinometers, Binoculars, Soil Cores	\$1,742.00	\$0.00	\$1,742.00
Contractual (identify)		\$0.00	\$0.00	\$0.00
Other Direct Expenses	Identify:	\$0.00	\$0.00	\$0.00
Total Direct Costs:		\$35,000.00	\$0.00	\$35,000.00
Indirect Costs:	See rules - Note 2	\$0.00	\$9,100.00	\$9,100.00
Gross Total Costs:		\$35,000.00	\$9,100.00	\$44,100.00
Add/Deduct Estimated Program Income			\$0.00	\$0.00
Total Project Costs:		\$35,000.00	\$9,100.00	\$44,100.00

Remarks:

Note 1: Other Federal cash contributions cannot be considered as part of Cooperator's 20% minimum contribution.

Note 2: Detail on Indirect Costs: If Cooperator is a State Cooperative Institution, no indirect costs or tuition remission may be charged against any federal funds provided under this agreement. If Cooperator is not a State Cooperative Institution, there is a 10% reimbursement limit on indirect costs (10% x direct costs = reimbursable indirect costs maximum.)

If equipment is being purchased, please check the appropriate statement:

Cooperator shall retain ownership of equipment when agreement terminates. (X)

Forest Service shall retain ownership of equipment when agreement terminates. ()

Financial Plan Instructions: (for worksheet page 1.)

(a) FS reimbursement to Cooperator: Maximum FS funding to be obligated under the agreement for reimbursement of FS share of Cooperator expenses.

(b) Cooperator Noncash Contribution: Expenses the Cooperator incurs that are contributed to the project for their share of project costs.

(c) Total of Columns A & B.

	<u>Indirect Cost Detail (G&A Staff will complete):</u>			
	Type of Rate: (Please enter X in adjacent column)			
	Provisional:			
	Predetermined:			
	Final:			
	Fixed:			
	Rate (%): 26%			
	Base (\$): 35,000			
	Total Amount (\$): 9,100			
	<u>Cooperator please check appropriate rate:</u>			
	Off-Campus Rate: [X]			
	On-Campus Rate: []			
	Not Applicable: Cooperator is not a University []			
	<u>Costs for Payment Purposes (G&A Staff will complete):</u>			
	<u>Contribution Determination</u>	<u>Payment Share</u>		
(1) Total FS Share = Gross Total Cost (a) /Total Project Cost (c)		<u>79.37%</u>	79%	
(2) Total Cooperator Contribution = Total Project Cost (b)/Total Project Cost (c)		<u>20.63%</u>	20.63%	
(3) Total of (1) & (2) should equal 100%		<u>100.00%</u>		
				(Revised 3/30/2001)